Handbook of Curriculum Development

Education in a Competitive and Globalizing World Series

Limon E. Kattington
Editor

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CONTENTS

PREFACE

Curriculum Development can be defined as the systematic planning of what is taught and learned in schools as reflected in courses of study and school programs. These curricula are embodied in official documents (typically curriculum "guides" for teachers) and made mandatory by provincial and territorial departments of education. The primary focus of a curriculum is on what is to be taught and when, leaving to the teaching profession decisions as to how this should be done.

Chapter 1 - The application of the controversial PBL strategy in medical schools was the most widely known major curricular intervention in the last century. As a response to the problems faced within traditional education, Mc Master University in Canada pioneered the 1st complete PBL curriculum in 1969. Nowadays, there are few Western medical schools that don’t include some aspects of PBL.

In recent years, PBL effectiveness and research has been a subject of considerable interest and debate. Although the research is still inconclusive, there is good evidence that PBL approach delivers on some very important issues. Process-based research concerned about the theoretical advantage behind PBL; it revealed PBL as a successful attempt to transform the effective learning theories into practical learning experience. Outcome-based research showed wide discrepancy in its results, many studies described PBL as superior to traditional methods in many students’ competencies especially in the social and cognitive dimensions; other reviews, however, found more similarities than differences between PBL and conventional approaches’ outcomes with no convincing evidence that PBL improve knowledge or clinical performance of the students at the magnitude of effectiveness hoped for with this major intervention.

The author of this chapter, as a PBL graduate and a faculty member in a pioneer PBL medical school in Africa, will reflect on the PBL experience after 40 years of its implementation in medical schools, discuss various controversial issues and debates on PBL, and throw some light on various PBL success/failure factors, explore how can/can’t PBL help in preparing the doctor of the future, what are the effective learning principles behind PBL, and the role of the accreditation programs in standardizing the educational processes in medical schools. The author also will critique the available educational research, and discuss the research needs in the current stage.

Chapter 2 - The authors have developed a Model of Formative Situation to Teach Science and Technology. It is intended as a basis for teachers’ decisions to achieve quality in teaching; and also a theoretical ground to practically relevant educational research. It embodies a constructivist view where the fundamental constructs are: students' world, tasks, teacher mediation and intended learning outcomes. The model guided several studies, conducted by us and several collaborators, and was improved in a permanent dialog between the evidences found and our theoretical elaboration.

Further developments led us to develop a Model for Effective Teaching of Intended Learning Outcomes in Science and Technology. This model articulates the contributions of science and technology educational research in the last four decades. It incorporates the research studies made by the authors and fifteen years of field work. The model encapsulates diverse teaching approaches and educational goals. It provides a reading grid of science and technology educational research papers to help teachers in making choices according to specific students' characteristics and learning outcomes. The model also intends to aid teachers in identifying directions for their professional development and to point directions for science and technology educational research.

Chapter 3 - Many higher education faculty members find themselves with the opportunity or requirement to design a new course, or to redesign existing courses or programs. In such situations they have a number of options for how to proceed, but may be unaware of these options. And despite the recommendations and examples provided by organizations such as the Mathematical Association of America, the authors lack objective guidelines for making curricular decisions and for evaluating potential curricular changes. Additional complications are encountered in the hard sciences, where evaluation of hypotheses typically occurs only after rigorous experimentation. With many curriculum experiments resulting in ambiguous or anecdotal data or lacking data whatsoever, the authors are faced with making decisions under a great deal of uncertainty. In this chapter, the authors will discuss five models for curriculum development that are founded on different concepts of the learning experience. Each is unique in its approach and each pairs with different types of learning goals and objectives. Like all curriculum models, these are an attempt to share with students some underlying knowledge structure, a structure that is essentially a mathematical object known as a graph or network. They can be generated through a kind of mind map or concept map and possess complex inter-relations among the components which often require a three-dimensional model to fully visualize. To construct any curriculum then requires that the authors take this complex structure in three spatial dimensions and project it into a single temporal dimension so that students can experience the curriculum over time. This projection is not unique, except for the simplest of knowledge structures. Thus, all decisions about curriculum development become equivalent to a single geometric question: How do the authors choose the best projection from which to view the curriculum? An alternative approach, the one taken in this chapter, is to go beyond a fixed curriculum or static projection to expose students to a hyperlinked curriculum. Rather than hiding the complexity of knowledge and its connections to the students, the hyperlinked curriculum is generated by students under the constraints, guidance, and support of teachers and in collaboration with others. These teachers are in turn supported by each other, linked together by administrators who seek to guarantee appropriate opportunities for all learners.

Chapter 4 - Oral presentation skills are recognised as central professional skills. In a majority of higher education curricula, courses are incorporated that centre on these particular skills. The present chapter starts with a conceptual discussion about oral presentation skills, and an in-depth discussion about the reliable assessment and evaluation of oral presentation skills.

But how can the authors design and develop an effective way to develop these oral presentation skills? It is difficult to find an answer to this question, due to a lack of a clear theoretical framework to guide instructional interventions. The authors introduce such a theoretical framework to understand how oral presentation skills evolve and can be influenced from an instructional point of view. As much as possible, the authors build on the scarcely available research results about the instruction of oral presentation skills. The authors adopt a social cognitive theoretical perspective towards self-regulated learning to develop a theoretical base for oral presentation skills instruction. In a systematic way, the authors link the theoretical base to the teaching and learning of oral presentation skills.

Four sub-processes of the observational learning cycle, derived from the social cognitive view, are put forward. Next the authors describe basic sub-processes of self-regulated learning, the cyclic model of self regulated learning and finally the transition from observation to self-regulated performance.

Chapter 5 - Curriculum materials are critical tools with which teachers plan for and teach science. Rather than using them as written, however, teachers often evaluate and adapt curriculum materials. To effectively engage in this process of curriculum design, teachers need to develop robust pedagogical design capacity, or their ability to identify and mobilize requisite resources, both personal and material, to develop effective learning environments. However, beginning elementary teachers face many challenges in learning to engage in curriculum design for science. They often lack substantial subject matter knowledge, struggle to articulate scientific inquiry in practice, and experience teaching contexts in which science is deemphasized. These factors mediate teachers' interactions with curriculum materials. To explore how elementary teachers learn to engage in curriculum design for science, three beginning elementary teachers were studied longitudinally over their first three years of professional teaching. Results show that the three teachers engaged in a substantial degree of curriculum design, drawing on a myriad of curriculum materials and modifying them to craft their own science curriculum materials. Their curriculum design efforts were influenced by their own views of science teaching, but also by features of their unique curricular contexts. Ultimately, alignment between the teachers’ views and the curriculum materials they used, as well as opportunities to engage in iterative cycles of curriculum design with a stable set of curriculum materials, were important in supporting their developing pedagogical design capacities. These findings have implications for the field's understanding of teacher learning along the teacher professional continuum and help inform research on teachers and teaching, as well as science teacher education and curriculum development.

Chapter 6 - This chapter presents the results of a qualitative study conducted at Copenhagen Business School of the possible links between full time graduate students’ identity and learning. Based on our empirical findings, the authors argue that students’ learning is closely related to their identity construction processes. The authors also argue that since there is diversity in terms of students’ identity construction and students’ approaches to learning, curricula should be developed to fit the individual learning needs of students. As such the chapter presents a move towards student- and learning centered curriculum development and it aims to inspire faculty and administration within higher education institutions to systematically address issues of identity and learning in their educational programs. The underlying argument is that such focus will help enhance students’ learning outcomes and at the same time help them in their creation of professional identities. The chapter will be of interest to curriculum developers, administrators of higher education, and teaching faculty interested in improving students' learning outcomes.

Chapter 7 - This paper describes a new second-year undergraduate project course in software engineering. The course aims to broaden students' experience, knowledge, and skills. The students worked on six one semester projects. The authors motivate and assess this pedagogy by our pre- and post-findings, and explain the rationale behind it. The outcome revealed that the students had the capability and motivation to engage in solving many complex managerial, organizational, and technical problems with little guidance and supervision. This suggests that they maintained their focus on the system rather than on individual tasks, which facilitated their understanding of the course material and software lifecycle.

Chapter 8 - Five years of service-learning data was explored for this mixed method study 1) describing the importance of integrating academic and social curriculum using subject area and service-learning standards and 2) analyzing the integrated service-learning projects by academic content, curriculum themes, service-learning types, impact on students. Total number of participants included 132 preservice teachers and 3500 students, prekindergarten to 2^{nd} grade. Data for this chapter is comprised of the 129 consenting preservice teachers' service-learning lesson plans, questionnaires, and focus group interviews and 563 student responses, which represent five randomly chosen students from each participating classroom.

Qualitative analysis utilized a starter list of codes for the initial readings of questionnaires, lesson plans, and focus group interviews; rereading and interpretation of the codes was used to create categories of meaning; and finally the categories were transformed into meaningful data by searching for patterns, themes, and regularities as well as contrasts, paradoxes, and irregularities (Delamont, 1992). Quantitatively, the data was entered into SPSS to ascertain the relationship between grade level, type of service-learning project, and what social effect the service-learning project had on the students 3 months later. In addition, a crosstabulation was used to analyze the relationship between service-learning type and curriculum content.

The chapter provides a targeted review of literature describing curriculum standards, service-learning standards, and the rationale for integrating them in teacher education programs and P-12 schools. Findings discuss 1) why social studies and science were the most often integrated academic standards in the 120 lesson plans, 2) the five curriculum theme categories and, 3) the significant impact of the academic and social curriculum on students.

Chapter 9 - This study, conducted with 28 sixth-grade students, investigated the effect of a summarizing teaching program on summarizing skills. The students were grouped as proficient and less proficient students and were presented teaching activities of 8 hours. The aim of this study was to comparatively test the effect of a) giving summarizing education, b) giving expository text (problem solving) education in addition to summarizing education against giving no summarizing education. Three study groups were used in the study: A Control Group (Group C) who were given traditional education, and two experiment groups. Experiment Group 1 (Group E1) was given both summarizing and text structure education, and Experiment Group 2 (Group E2) was given summarizing education. The results of the study show the positive effect of the teaching program on the experiment groups. The groups who were given summarizing and text structure education were more successful than the ones given only summarizing education.

Chapter 10 - Changing times and postmodern perspectives have changed the traditional beliefs about child development knowledge, early childhood learning and curriculum and their relationships. Despite ongoing exchanges about how best to respond to the critique of the developmental knowledge base, few descriptions of how particular educators have reconceptualized their curriculum exist. Employing postmodern views of knowledge, learning, and curriculum, this chapter describes a new narrative curriculum developed by the authors to enact a postmodern early years learning in a typical Chinese context: Story Approach to Integrated Learning (SAIL). It first reflects on the existing early childhood curricula in Hong Kong and the associated problems and challenges. Second, it reviews the literature about the reconceptualization of early years learning and curriculum to seek possible solutions to Hong Kong problems. Third, a brief introduction of SAIL is presented and an example is given to illustrate how SAIL can put postmodernism curriculum into practice. Last, this chapter concludes with a discussion of some of the challenges and future directions relating to the shift from developmental to postmodern practices in the development of early childhood curriculum.

Chapter 11 - To promote STEM (science, technology, engineering, and mathematics) education with American Indian students in grades 5-8, a civil engineering focused curriculum was designed through collaboration among educators, researchers, and engineers. The curriculum was created to introduce American Indian youth to career opportunities in civil engineering, various civil engineering concepts, and the role of civil engineers in the technology driven 21st century. The emphasis of the curriculum is placed on structural engineering, which is a branch of civil engineering concerned with the design and structure of buildings, bridges, and roads. The curricular activities focused on one particular structure - bridges. Through the activities the students engaged in engineering, as well as science, mathematics, and technology.

Chapter 12 - A science curriculum should emphasize the nature of science, and foster the development of scientific habits of mind within the student population. This is particularly important within science content courses designed for practicing teachers, who will teach the subject matter as well as model scientific methods within their own classrooms. Previous science educational research revealed that inquiry-based and active learning strategies in traditional classrooms can result in meaningful student learning, but the translation of these methods in online environments is far less researched. Therefore, the authors focused on science curriculum development in the online environment by which science content, the nature of science, and scientific habits of mind can be conveyed to practicing teachers.

Through numerous semesters (N = 10) and a variety of online science courses (N = 6), our research demonstrated that online science curriculum development proceeds successfully through incorporation of SCALE. The online science curriculum should focus upon Self-directed autonomous activities, Community-based learning, both within an online environment and within the teachers' local areas, Active-learning strategies that move practicing teachers beyond the confines of the computer environment, and Local Environment incorporation for easy access and relevance to individual online learners. The SCALE method allows for interdisciplinary and integrated science curriculum in a variety of online science environments. The resultant content is consistent with the theory of human constructivism, which stresses that "less is more," and it emphasizes meaning over memorization, quality over quantity, and understanding over awareness.

SCALE can be accomplished through autonomous informal activities utilizing teachers' local field sites, history of science investigations, online community discussions, and interdisciplinary topic portals for self-directed research and classroom implementation. Our mixed methodology research investigations indicate that more successful learning occurs within an online science SCALE curriculum. SCALE may also result in more positive teacher attitudes toward online science courses.

Chapter 13 - While the social, political, and employment contexts of practicing archaeology have changed over the past 30 or so years, curriculum structure and content and post graduate opportunities have remained relatively unaltered well into the 1990s. One reason for this is the development of archaeology as an academic, university taught discipline. For over 100 years, archaeology has been a formal academic discipline taught as one of the four classic sub-disciplines of anthropology, and the traditional professional outlet for most archaeologists has been the academy (Michaels 1996:192). However, given how archaeology is currently practiced it has, by necessity, expanded beyond the academy.

Archaeology has changed significantly, not only in method and theory, but with respect to its obligation to help manage cultural heritage in the public interest. As a result, professionals have had to rethink how students are educated and trained in order to meet the new challenges of a century in which the majority of archaeologists are employed outside the academy in governmental and private sector settings (Smith et al.1995; Zeder 1997). It is also clear that students must have both an academic and a pragmatic understanding that heritage resources are nonrenewable and finite and must have complete and substantial documentation; that archaeologists do not have an exclusive right to the interpretation of the past; and that many people besides archaeologists have a vested interest in the past and its material remains.

The need for public support for archaeology demands that students must also be able to demonstrate the discipline's relevance in contemporary society, especially within the contexts of professional ethics and values and competing national and international agendas. Especially in a strained economy, the use of scarce resources must be carefully designed and justified. Students must be able to effectively communicate both within the profession and with the public through written and oral media and to apply archaeological method and theory to issues and problems, some of which might be influenced by factors outside the heritage arena. To deal with the changing demands of the profession two initiatives were undertaken by the Society for American Archaeology (SAA) – Teaching Archaeology in the 21st Century and Making Archaeology Relevant in the 21st Century (MATRIX).

Both the Teaching Archaeology in the 21st Century and MATRIX initiatives grew out of earlier activities undertaken by the SAA. The first was the 1989 "Save the Past for the Future" working conference followed by the second "Save the Past for the Future" working conference in 1994 in which recommendations regarding formal education and professional development were pursued.

Participants in the Teaching Archaeology in the 21st Century initiative made recommendations on how those needs outlined above could be addressed by the undergraduate and graduate curriculum. Central to their mission was the notion that one of the most potent means for combating rapid destruction of the archaeological record was the education of diverse publics about the value and significance of knowledge that could be produced through archaeological inquiry (McManamon 1991). Over time this perspective has expanded to include the idea that public engagement in both research and interpretation is also essential to preservation. From the outset, the students that archaeologists teach formally were considered a key component of this audience.

Chapter 14 - The paper examines the implications of critical ethnography for curriculum in studies on transnationalism and the internationalization of higher education. It suggests that as universities in Australia are being integrated into the new global system of transnationalism in higher education, particularly with students from the Asian sub-continent, there is a need for re-strategizing in universities in the areas of curriculum and pedagogy to enable transnational learning communities and generate and sustain empowering knowledge networks. There are three main sections to the paper. The first section of the paper focuses on the conceptual framework for the paper by citing the works of James Clifford (1997). The second section examines the internationalisation of higher education in Australia with an analysis based on interviews with transnational students from the People's Republic of China. The final section provides practical conceptual resources for making innovations in education policies, pedagogies and politics through the internationalisation of higher education.

Chapter 15 - Jenkins et al (2006) expanded the discussion of media literacy, arguing for a paradigm shift from a focus on individual expression toward one on community involvement. In addition to the skills traditionally emphasized by media educators, a set of social literacies becomes indispensable as students learn to navigate their way through cyberspace. This paper aims to strengthen the case for the social literacies by arguing for their centrality to twenty-first century civic education. It first describes how the emerging participatory culture is offering abundant opportunities for young people's civic engagement: by promoting open and thoughtful civic discourse, by facilitating the mobilization and organization of collective action, and by encouraging the expression of civic voices through media production. It then argues that in order to take full advantage of these learning opportunities, young people need to acquire the social literacies—in particular, the skills of negotiation, collective intelligence and networking.

Chapter 16 - A rapid and dynamic change in science, technology and social life is being experienced around the world. Nations, which want to adapt themselves to this change and have adopted continuous advancing as a principle, attaches special important to science education (Ayas, 1995; Ünal, 2003). No doubt, quality of education programs is a determinant in quality of science education. Therefore, it seems that innovative and enterprising changes to be done in science education may become possible if education programs are contemporized.

To raise quality of science education, studies on program development should be continuous and novelties in science and trends in education area should be taken under consideration during this process (Ayas et al., 1993). In addition, failing aspects of current and previous programs should be determined and faults, which have occurred in the past, should be discovered within program development process. Accordingly, investigating the programs, which have been developed in the historical process, from the point of view of planning, practicing and evaluating has an important role in improving quality of the programs to be developed in the future.

Due to this reason, the science programs, which have been developed in Turkey, are presented in this study in chronologic order with a criticizing point of view by considering program development processes.

Chapter 17 - The changing context for quality assurance and enhancement in education in the UK and elsewhere presents both an opportunity and a challenge because it offers the possibility of integrating sustainable development into all quality systems. One consequence is the alignment of a number of policy developments to provide a more coherent and integrated approach to performance management and relevant outcomes in our education institutions. More fundamentally it raises the following questions:

- Should sustainable development be an integral component of all quality assurance processes and standards in our education systems?
- Does education which embraces sustainable development contribute to a transformative learning experience and thus better performance by learners?

This paper assesses current developments in quality assurance and enhancement in the UK's education sector and how this evolving agenda is approaching the question of integrating sustainable development within it. It also questions how far current processes of promoting sustainable development might contribute to student performance and to the development of good practice in teaching and learning.

Chapter 18 - This study aims to explore the curriculum reform initiated in 2005 in the secondary level education in Turkey with special reference to its impact upon *Anatolian high schools,* highly competitive schools in Turkish education. A large-scale survey was administered to 170 teachers and 851 students in order to determine their perceptions of this recent curriculum implementation. In the analysis of the survey questionnaire, both descriptive analysis and content analysis were employed. Findings indicated that despite disagreements in the perceptions of teachers and students on some issues, both groups of participants had a favorable opinion on many aspects of the curriculum innovation. It is suggested that the findings be evaluated within the overall framework of the current education system.

Chapter 20 - Media education has been around for quite some time in the West (Bazalgette *et al*., 1990), but only started to gain acceptance in Asia (Cheung 2005), particularly in Hong Kong, in the last decade. Recently, it has been gaining more attention in Hong Kong thanks to the curriculum reform in which Liberal Studies will become one of the four core subjects to be taken by students in the New Senior Secondary Curriculum and media is one of the six themes to be studied in the subject of Liberal Studies. This paper argues for the need for teaching media education in liberal studies and shows the many connections between the two subjects that facilitate this integration.

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Chapter 1

"CURRICULUM DEVELOPMENT IN MEDICAL EDUCATION: A REFLECTION IN THE 40 YEARS - EXPERIENCE OF PROBLEM-BASED LEARNING (PBL), THE EDUCATIONAL RESEARCH AND THE ACCREDITATION PROGRAMS OF MEDICAL SCHOOLS"

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ABSTRACT

The application of the controversial PBL strategy in medical schools was the most widely known major curricular intervention in the last century. As a response to the problems faced within traditional education, Mc Master University in Canada pioneered the 1st complete PBL curriculum in 1969. Nowadays, there are few Western medical schools that don't include some aspects of PBL.

In recent years, PBL effectiveness and research has been a subject of considerable interest and debate. Although the research is still inconclusive, there is good evidence that PBL approach delivers on some very important issues. **Process-based research** concerned about the theoretical advantage behind PBL; it revealed PBL as a successful attempt to transform the effective learning theories into practical learning experience. **Outcome-based research** showed wide discrepancy in its results, many studies described PBL as superior to traditional methods in many students' competencies especially in the social and cognitive dimensions; other reviews, however, found more similarities than differences between PBL and conventional approaches' outcomes with no convincing evidence that PBL improve knowledge or clinical performance of the students at the magnitude of effectiveness hoped for with this major intervention.

The author of this chapter, as a PBL graduate and a faculty member in a pioneer PBL medical school in Africa, will reflect on the PBL experience after 40 years of its

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implementation in medical schools, discuss various controversial issues and debates on PBL, and throw some light on various PBL success/failure factors, explore how can/can't PBL help in preparing the doctor of the future, what are the effective learning principles behind PBL, and the role of the accreditation programs in standardizing the educational processes in medical schools. The author also will critique the available educational research, and discuss the research needs in the current stage.

INTRODUCTION

Controversial or not, no body can deny that after 40 years of its implementation in medical schools; Problem-based learning (using problems as a trigger for learning versus discipline, lecture-based learning) is considered the most widely used major curricular intervention in the last century. Educationalists have witnessed many trends and innovations in medical education curricula: multidisciplinary approaches to science and education and integrated curricular structures, outcome-based medical education, competence-based and performance-based assessment, community-based education to provide learning experiences outside of academic medical centers, use of simulators and standardized patients in clinical teaching and assessment, innovative assessment tools such as objective-structured clinical exam (OSCE), portfolios, and different forms of written and clinical exams, learning styles and adaptive learning where learning is adapted to meet the needs of individual students, e-learning and frequent use of technology, global perspective of medical education, new organizational structures to support teaching – such as academies of medical educators, mission-based management, and faculty development programs –, patient-management problems, behavioral objectives and teaching professionalism, patient-centered medical education with respect to patient-safety principles and use of patients as assessors, evidence based medical education, quality assurance and accreditation in medical education, and more. However, PBL was the only radical curricular change that spread globally like wildfire. During the last four decades, several higher education institutions all over the world have initiated new programs or restructuring existing ones based on PBL. However, since its introduction in the late 60s, PBL has raised considerable interest and intense debate among those involved in medical education community. The theoretical basis for PBL, outcomes of PBL compared to conventional curricula in terms of students' competencies, cost-effectiveness of PBL, pros and cons of PBL, strength of the empirical evidence and integrity of the PBL research coming out from studies aimed at comparing conventional and PBL curricula, and many other argued issues have risen in this debate. The aim of this chapter is to throw some light on the whole PBL experience as a significant curricular development intervention in medical education after 40 years of its implementation in medical schools, to reflect on some aspects and impacts of this challenging strategy, and explore and comment on various facets of the debate about PBL. The chapter also aim to investigate different controversy issues and challenges that face research in medical education and discuss the role of the accreditation programs of medical curricula in standardizing the educational processes and teaching strategies in medical schools as a modest trial to help develop effective learning environment for our students, and identify our current curriculum development needs in medical schools.

1. HISTORY OF PBL: AN OLD PERFUME IN A NEW BOTTLE?

There is a belief that the PBL is an old approach of learning that was started with the primitive man when he first-experienced his new life on Earth and faced the challenges of living within a wild environment, fighting various predators and was in need to protect himself and to supply his family with their requirements of food, shelter, and security. Problem-based learning was the process that enabled the primitive man to survive and to continuously improve life on Earth by dealing with the unknown problems, looking for cues, analyzing and synthesizing available data, gathering information, developing hypotheses and assessing them using strong reasoning. Since the PBL philosophy emphasizes the principles of student-centered and active learning and the fact that the student can learn without a teacher, the primitive man also used to learn in the absence of the teacher in an actively-directed manner. Moreover, PBL is the approach that the children employ in discovering their world around while they experience it for the first time, the approach that is mainly problem-based and learner-centered. For example, if the mother told her baby several times not to touch the hot pot because it hurts, the baby will not learn this fact immediately, but if he touches the hot pot and realize, himself, that it hurts, he will acquire the information solidly and permanently.

In some old beliefs, the role of the teacher is to teach the students how to learn rather than to provide them with a ready-made experience or knowledge, a main concept of the PBL approach. In this regard, the old Chinese said "Instead of giving your child a fish, teach him how to fish", and also "give your child a fish, he eats for today; teach him how to fish, he will eat for his whole life". Moreover, in some cultures as in my country, Egypt, PBL maybe considered as a religious mode of learning. In this culture, people may believe that God, the creator of the universe, while doesn't show himself to people, he asked them to recognize his presence themselves actively; and asked people to notice, observe and study various creatures, different observable phenomena and events on Earth and in space, and to examine various evidence to reach a conclusion that there is a creator for this universe. It is a cycle starts from the concrete to the abstract in order to gain knowledge. People in my culture may also believe that God sent prophets to people (as the first teachers) just to remind them, as guiders, that there is a creator who deserves to be worshiped; the prophets were not sent to dominate or force people to believe in their God, instead, prophetic teaching reflected most features recognized today as student-centeredness. The role of the prophets as of teachers, in this culture, is to facilitate the learning process for the students who should be active participants in the educational course; the principles in learning that are supported by the PBL approach.

From the above description , one can conclude the use of the actively- directed and problem-based learning might not be considered as recent innovation discovered only 40 years ago but rather may constitute an old perfume in a new bottle.

Modern PBL as we know today, however, was initiated in the last century and precisely in 1969. As a response to the problems faced with traditional medical education, modern PBL was originated in McMaster University in Canada. When the medical school opened and the undergraduate MD program admitted its first charter class of 20 students, the curriculum planners and teachers, in this school, were disappointed with traditional teaching because too many students memorized, forgot, failed to apply or to integrate knowledge, and resisted further learning; the curriculum planners were also very concerned about the explosion of biomedical knowledge. The method's founding fathers were an iconoclastic group of physicians and basic scientist who were recruited to work in the new school; they all shared a negative view of their undergraduate experiences and thought they could do better job [1]. They aimed to educate a graduate to have the skills to deal with information explosion through self-directed learning, information search and retrieval skills, critical appraisal, and self-assessment. The aim to give only the essential information which all student should know in each part of the course, ad have some fun doing it rather than overcrowding the students with too much irrelevant factual details useful only for passing exams but not for practicing medicine. The curriculum in McMaster was designed also to open with an integrated approach as an alternative to the conventional medical courses, in which most of the information was delivered in separate disciplines of anatomy, physiology, pathology,…etc. The 3-year PBL curriculum, which emphasized small-group tutorials, self-directed learning, a minimal number of didactic presentations, and student evaluation that was based mainly on the students' performances in the PBL tutorials, presented a radical curricular intervention in medical education that has influenced students around the world.

Some may think that the origin of the three key features, that subsequently known as "the McMaster philosophy" namely: the self-directed learning, the small group tutorials and the PBL, was not very clear in the history and McMaster University may not be the pioneer in regard with adopting such approach. Instead, problem as stimulus for learning may be an attempt to adapt the case study method of Harvard Business School to medicine. Besides, self-directed learning was an idea spread in a popular book in 1960s, and tutors and small groups may simulate the tutorial systems at Oxford/Cambridge [2].

Within a few years of its implementation in McMaster Medical School, and to everyone surprise, the method caught on like fire [1]. Several universities adopted PBL as a new approach to medical education since that time; PBL gained a great popularity within many schools in higher education too [3]. Maastricht University Medical School in the Netherlands was the first follower in Europe started in 1974, and then many universities in the United Kingdom, United States, other countries in Europe, Australia, Asia, and Middle East introduced elements of PBL. My faculty of medicine in Suez canal University/Egypt pioneered the first completely problem-based learning with integrated, community-based approach in Africa in 1976; and the method is continuing to spread. Now, there are few Western medical schools that don't include at least some features of PBL during their instructional program. Taking a country like USA, the use of PBL is widespread in the preclinical curricula of its medical schools; Kinkade, 2005 [4] surveyed 123 medical schools in the U.S.A., asked whether or not they were using PBL. Of them, 70% used PBL in the preclinical years. Of schools using PBL, 45% used it for less than 10% of their formal teaching, while 6% used it for more than half of their formal teaching. Of the 30% of schools not using PBL, 22% had used it in the past, and 2% had plans to incorporate it in the future [4]. PBL strategy has also been taken up in other fields of professional training (e.g. nursing, architecture, engineering) however the adoption within humanities and social sciences is much less developed [5] because it has been argued that it is easier to use in applied than theoretical disciplines. Many educationalists in the social sciences, however, see themselves as already teaching using a problem-based approach long time ago although such approach are rarely benefit from the structural integration of individual and group work that PBL advocates [5].

Moreover, and as will be presented later in this chapter, many aspects of the PBL philosophy were recommended recently as quality standards in medical education and constituted essential requirements for accrediting medical schools' educational programs according to different accrediting organizations.

2. What Is PBL? Is There Only One Form of PBL?

2.1. Definition of PBL

Problem based learning (PBL) is a term used within education for a range of pedagogic approaches where learning is driven by challenging, exploring open-ended problem, students work in small groups, use problem case or scenario to define their own learning objectives, learning is facilitated by a tutor, courses don't exist, and lectures are minimal. Problem based learning describes techniques that make students take an active, task-oriented, and self-directed approach to their own learning. PBL is not only about problem solving or finding an answer to a question (finding an answer to a question is not really a problem based-learning); rather problems are used to acquire knowledge and increase understanding. PBL also combine the acquisition of knowledge with the development of other generic skills and attitudes (as will be presented in this chapter). while teachers in conventional curricula tend to start by providing information and then expect students to use the information to solve problems (from the abstract to the concrete), in PBL, the problem comes first; students work with an unknown problem, define the problem, look for relevant cues, analyze, synthesize, and critique available data, develop hypotheses, and gather information to explore it, and finally attain facts or theories (from concrete to abstract). Comparable to other conventional curricula, PBL is considered as a method of learning that ethically respects the students' rights and autonomy to control their learning, to critically think, appraise, and discover information while learning rather than being passively-stuffed with enormous amount of forgettable details. It is the gold-finder approach versus the sponge -stuffing approach.

2.2. PBL Elements, PBL Process

Although several variations of PBL systems exist in different schools and the details of how the PBL process is implemented differ from an institution to another, three characteristics are common components: problems as trigger for learning, tutors as facilitators for student-centered learning, and group work as stimulus for interaction [6].

1) The Problem

Students in PBL face problems as a trigger for learning. The problems are a description of phenomena that need to be explained. When trying to explain the phenomena in the problem, students discover that they already know some knowledge about the problem, but they also realize that they don't know enough and still there are some questions to answer and require further study. So problems are the driving force behind learning [6]. They drive active engagement of the students in their own learning and stimulate students to construct new knowledge actively and to connect it with the previous knowledge. Problem is the focus for acquiring new knowledge and fosters flexible thinking [7]. Real-life patient clinical scenarios are often used, however there are other examples and formats of problems as trigger materials for learning such as experimental or laboratory data, photographs, video clips, newspaper articles, all or part of an article from a scientific journal, a real or simulated patients, a family tree showing an inherited disorder, a letter from a doctor, medical research problem, problem in a health care delivery system, administrative or team function problem in a health team…etc. all constituted practical formats that are being used in different institutions [8], however paper formats are the most-commonly used design to deliver case material; the latter format is preferred because it has the opportunity to ensure that all the students in the school are exposed to the same studied problems. However, there is little evidence that paper clinical scenarios, although simulates clinical scenario, will improve the students' clinical practice, so recently other institutions introduced real patients in place of paper scenario and to overcome the ad-hoc nature of using real-patients and for ethical consideration, other schools turned to use simulated patients to deliver the key cases needed to be covered by all students.

2) The Tutor

The teacher in PBL is not an information provider, an answering man, or a key figure in the educational theme, rather the tutor is a facilitator for the learning process that should be actively directed by the students who are the center of the educational process. The tutor task is to keep the learning process going on the right path, to check out the students' knowledge deeply, to ensure that all students are involved actively in the learning process, to monitor the educational progress of each student in the group and to modulate the challenge of the problem [9]. Facilitating a small group tutorial requires the tutor to perform two roles:

1. Group maintenance role as to ensure that: the group functions well, all students are participating in the discussion, nobody is dominating at the expense of others, conflicts are resolved, and to give an introduction for the session.
2. Task role where the tutor guarantee that the task is completed and the outcome is accomplished and the group achieves the appropriate learning objectives in line with those set by the curriculum design team. Tutor may explain the task, question understanding, keep time, clarify and summarize progress, and other actions that facilitate learning and keep discussion on track. At the end, the tutor may close the session, evaluate and give feedback to the students about their performance. In other words, the role of the tutor as being a facilitator in PBL makes learning in PBL a self-directed process.[10].

There are some controversial issues regarding the tutor element in PBL. Some institutions prefer to use expert tutors while others prefer non-experts to facilitate the PBL sessions. The efficacy of the expert/non-expert tutor and the definition of the expert tutor, the skills which are more important for the effective tutor, are they the facilitating skills or the content knowledge, and what are other characteristics of the good tutor; all are points of disagreement in implementing the PBL approach in various institution. Some schools turned recently to recruit expert tutors with content knowledge claiming that the students value the experience of the tutor and behave differently in the presence of an expert tutor who is also more able to give an effective feedback to the students about their performance in the PBL tutorials. Other institutions hire psychological therapists or social workers claiming that they can help students to gain various social and generic skills, while some schools get benefited from their senior students in running the PBL tutorials with satisfied results [11].

3) The Small Group

Although conducted in several ways, use of group work as a stimulus for interaction, learning and developing generic skills constitutes the third characteristic component of the PBL approach. Typical PBL tutorial consists of a group of students; usually 6-8 beside the tutor, five or less students would negatively affect the brain storming process and decrease the number of the raised valuable ideas, while 10 or more students may limit the available time for every member to participate effectively and to adequately cover various discussable points. The length of time and number of sessions that the group stays together with each other and with individual tutor vary between institutions. Typically two sessions are organized for each problem separated by a free study period, these are the brain storming session and the debriefing sessions:

The Brain Storming Session (Discussion Session in other schools): In this first session, the presented problem is discussed in the group in a collaborative learning environment with an end result that students recognized their knowledge gaps and learning needs in the form of some learning objectives needed to be covered in the following phase. Some schools may allow the students to divide these learning objectives among them, then everyone to have the responsibility to explain what s/he has studied to other members of the group, other schools find it would be more collaborative learning if each student studied all the raised learning objectives to enrich the discussion in the group session on using variable learning resources by the students for each topic [8].

Free Study Period: After the end of the brain storming session, the students have a few days free self-study period (differs in length with institution) in which the students are free to select their own learning resources (text books in the library, websites in the internet, subject-matter faculty expert, lectures, skill lab, other laboratory sessions,….etc) to collect information about the learning issues raised in the 1st tutorial session.

Debriefing Session (Outcome or Review Session in other schools): The students then meet again to discuss what they have been collected and share results.

During the PBL group work, the student collaborate to learn by interacting with each others, e.g. explaining the materials to other students, asking and answering questions, and by discussing various issues using words, drawings or diagrams. Students learn to work together in a team [12], acquire several generic skills such as problem solving skills, critical thinking, debating and negotiating skills, conflict management, dealing with uncertainty, decision making, communication skills, clinical reasoning …etc. Students elect a chair for each PBL scenario and a scribe to record the discussion progress and the achieved learning objectives on a paper or on a whiteboard. Several other roles are played by the students in the sessions (will be highlighted in the following part of this section) ; some roles are rotated for every scenario or every unit. On the beginning the learning unit, students may be given a study guide with a content varies with the institution. This student guide may contain some information about the general learning objectives of both the block and the phase, some learning resources to be used optionally by the students, or other guided tips for the students.

2.3. Student Roles in the PBL Tutorials

Twelve skills are suggested for the students to work effectively in the small group session [13], these are:

1. Keep the ground rules or the settled group norms such as: everyone has the right to express his view, debate rather than argue, not to spend too much time on one issue, respect each other and avoid personal comment, focus on the discussion of the case and avoid sidetracked discussion or negative arguments.
2. Know different roles of the student and its requirements: as a chair-person, a scribe, a word finder, a group representative, a group recorder, a group member involved in the case discussion to help session progress...etc
3. Keep group dynamics: reflect, focus on the goals , ask what did the group achieved, what can be achieve next time, be positive, work effectively with others, ask what did you add to the group, use individual and cultural difference to empower the group dynamics...etc
4. Ask empowering questions: This includes good open-ended questions that empower the discussion, understanding and learning, doesn't ask shallow questions that focus on details.
5. Be a purposeful learner: plan own learning, monitor progress, be self motivated, acknowledge own gaps, not afraid to ask for help, have continuous desire for learning, be able to integrate information together, develop reasoning skills, be a critical thinker...etc
6. Get a feedback: get the best out of the tutor's feedback, get benefit of the peer assessment in the group, and plan how to use the feedback to improve own learning ...etc
7. Monitor own progress: by self evaluation and motivation, keep progress journal, discover area of strength and weakness, plan to fill the gap…etc
8. Strive to be a winning team: believe that group success is the outcome of every member contribution
9. Be a critical thinker: analyze complex issues, use thinking abilities to the fullest, put hypotheses, look for supportive evidence, evaluate data, synthesize information, establish links, identify area need further research, have an organized discussion, have a passion for understanding and solving problems, explore different aspects of an issue, debate rather than argue, have a questioning manner in learning….etc
10. Know the role of the tutor
11. Turn to winning attitude: be persistent, select a model to follow, see opportunities for success in challenges…etc

12. Be collaborative learner: create a climate of trust, ask others for help, listen to the other views, share information and resources, provide descriptive rather than evaluative or judgmental comments, and always say “we” not “I and you”.

From the previous description, it is recognized that there is no rigid rules that must be followed on implementing the PBL approach in all institutions, rather there are general characteristic elements of the process (the problem, the tutor, and the group work) and the curricular manager can adopt PBL to suit local needs of the schools. The following is the Maastricht 7 steps (seven jump process) as an example for what is happening in the PBL tutorial sessions in Maastricht School of Medicine, the pioneer of PBL in Europe.

PBL tutorial process in Maastricht University [8]

Step 1—Identify and clarify unfamiliar terms presented in the scenario; scribe lists those that remain unexplained after discussion

Step 2—Define the problem or problems to be discussed; students may have different views on the issues, but all should be considered; scribe records a list of agreed problems

Step 3—“Brainstorming” session to discuss the problem(s), suggesting possible explanations on basis of prior knowledge; students draw on each other's knowledge and identify areas of incomplete knowledge; scribe records all discussion

Step 4—Review steps 2 and 3 and arrange explanations into tentative solutions; scribe organizes the explanations and restructures if necessary

Step 5—Formulate learning objectives; group reaches consensus on the learning objectives; tutor ensures learning objectives are focused, achievable, comprehensive, and appropriate

Step 6—Private study (all students gather information related to each learning objective)

Step 7—Group shares results of private study (students identify their learning resources and share their results); tutor checks learning and may assess the group (8).

2.4. PBL: Never be One Single Approach

Do we mean the same thing when we say PBL? The answer is No; implementing PBL in different places takes various forms, all lie under the title of problem-based learning, and this leads some to distinguish the classic PBL which sticks closely to a set of particular principles and processes first organized by medical educationalists at McMaster University. In this regard, Barrows, 1986 [14], described the original PBL as “a genus” for which there are many species and subspecies, each addresses one or some of the PBL characteristics (which are learning in clinical contexts, developing effective clinical reasoning, self-directed learning, and increased motivation) to varying degrees. A continuum of approaches exists between a fully problem-based curriculum at one end of the spectrum and an information providing oriented curriculum at the other end passing through problem-oriented learning, problem-assisted learning, problem-solving learning, problem-focused learning, problem-based mixed approach, problem-initiated learning, problem-centered learning, problem-centered discovery learning, problem-based learning, and task-based learning as examples [15]. Some feel that there can never be one single PBL approach to all teaching and learning contexts [1], PBL may be used either as a mainstay of an entire curriculum or for the delivery of individual courses, the length of the medical school program may vary from 3 years e.g. in Maastricht University to 6 years e.g. in McMaster university, blended forms or mixture of both PBL and conventional curricula are introduced too...etc. Team-Based Learning (TBL), Case-Based Learning (CBL) and SPICES model are examples for other approaches that hold some features of the PBL and are being employed increasingly in medical education. Here are some details about the last three approaches:

Team-Based Learning (TBL) [16, 17, 18]*:* is a well-defined instructional strategy that was developed originally for business schools and other higher learning settings [19, 20]. The approach includes both individual and group assignments; it allows a single instructor to manage multiple small groups simultaneously in 1 classroom. TBL has garnered interest within the medical education because of its potential to promote active learning without requiring large number of faculty facilitators [21]. Pure TBL consists of 3 repeating phases. During the first phase (preparation phase), learners study materials independently outside class. During the second phase, learners complete a test to assess their basic understanding of facts and concepts included in phase1. During the third phase (application activities), students work in class of teams lead by the instructor on assignments that provide the opportunity to apply phase 1 and 2 knowledge in real life problems. Some further modifications to this classic TBL were introduced in some medical schools.

*Case based learning (CBL)****:*** CBL is another alternative model to traditional PBL that has become an integral part of some medical school’s curricula [22]. Compared to PBL, the fundamental difference is that PBL require no prior experience or understanding in subject matters related to the problem whereas CBL require a degree of prior knowledge that assists in solving problems, here students recall previously-covered material to solve clinical cases. Both methods share common goals, but in PBL the problem drives learning while in CBL the students are given some advance preparation. The problem design is more structured in CBL with fewer unfocused tangents, it employ guided inquiry rather than open inquiry, both student and tutor share responsibility for learning and both provide some direction during the tutorial discussion. Student can use the tutor as a subject matter expert, asking him/her some questions during the session which is not purely self-directed or student-centered. CBL provides less busy work, more opportunity for clinical skill application, save time, help student focus on key points, and the students have little post session work. The CBL approach is more preferred by the students and the teachers than PBL in some schools that implement both approaches [22].

The SPICES model is another alternative model where some other strategies are added to the problem based learning approach. It is a curricular package consists of six educational issues introduced to the conventional curricular system, namely: Student-centered versus Teacher centered, Problem-based versus Lecture based or Information gathering, Integrated versus Discipline based, Community-based versus Hospital based, Electives versus Standard program, and Systematic versus Opportunistic approach. The issues involved in the *SPICES* model provide a framework around which a more meaningful discussion about curricular planning can take place and medical schools can decide where they stand on each issue which is really a spectrum between two extremes; so the position of a school may vary depending on the educational advantages of each one of the 6 approaches, the aims of the school, and the practical and logistic considerations [23]. Some argue that: as too many spices in the food make it unappetizing and maybe harmful, so too in the curriculum, where introducing too many *SPICES* may lead to curricular erosion and threaten the acknowledged fundamental principles of the medical education profession.

3. Can PBL Be Implemented in Low-Resourced Countries? PBL Experience at Suez Canal University, Egypt

In1976, the newly-developing Faculty of Medicine at Suez Canal University in Egypt implemented a problem-based, multidisciplinary integrated, community-oriented undergraduate program that constituted 100% of the educational program. The program encompasses a 6- year's curriculum with three sequential phases followed by a year of internship (where graduate works as house officer undergoing training in various specialties), and then the graduate awarded the MBBCH degree.

From my experience as a student (from year 1982- 1988), the following features characterized the educational program (thereafter, many modifications were introduced to the original classic curriculum): The first year (phase I) focused on normal, healthy human in different stages of life. In phase II (year 2, 3), logical sequences of body system-based units were delivered in blocks of 4weeks, in which domain knowledge from a variety of disciplines is presented in an integrated way. In Phase III (year4, 5, 6): More concentration on clinical teaching was added to the theoretical teaching in different specialties. Tutorial PBL groups formed the backbone of the approach, basic science disciplines were not taught as isolated disciplines, but integrated with clinical sciences and organized around themes that centred on specific organs in a context of patients' problems. The foundations of this educational approach represented student-centered, self-directed learning, very few lectures not exceeding 3 hours per week and students spent most of the learning time on independent study. PBL tutorial sessions constituted 5 hours a week, 2 h for the discussion (brain-storming) session and 3h for the debriefing (output) session in addition to one seminar weekly during which subject matter experts joined the students for any inquires regarding the weekly-studied problem. Early patient contact (started in the earliest few weeks of the first year), extensive clinical training in primary, secondary, and tertiary health care facilities with more concentration on primary and community health care, and continuous training in communication skills (with patients, their families, colleagues, and health care team) were also focused on. Remaining hours were spent in training in skills lab, practical training in various laboratories, clinical rotations, and field trips to various health care delivery facilities and different community centers including homes of patients in different socioeconomic classes. Elective courses were also available in the form of involvement of students in various research studies. Assessment of students in each block included: 1) Assessment in the PBL tutorial sessions (formative and summative tutor assessment as well as formative peer and self assessment); skills such as critical thinking, problem solving, demonstration of knowledge, tem work, and other group's and individual's roles in the tutorials were highlighted. 2) Written tests after each studied block which were mainly problem-based (context-rich) essay questions aimed to assess various levels of cognition and learning objectives. 3) Clinical and interview skills were assessed initially in the skills lab on simulators and standardized patients and later on with real patients in the clinical teaching sites. 4) Other practical skills were assessed in various laboratories (microbiology, biochemistry, pathology...etc). 5) Students also were given the opportunities to reflect on various learning experiences through presenting, what we called at the time, *Appraisal Reports* (portfolio today) on such experiences and students were assessed on these reports too. Summative assessment results have not been presented to students in the form of scores, rather it was either (satisfactory or unsatisfactory performance); the aim of the student assessment was not to enhance the competitive spirit between students or to classify students according to their scores, but to show where the student were on the educational track.

The mission of the Suez Canal faculty of medicine was to prepare its students for meeting and responding to the - up to date- local and global changes and challenges in health care field and to satisfy the expectations of their community. The main outcomes expected in the graduates were critical thinking, problem solving, life long self learning skills, and scientific attitude. More focus was given also to the communication and team work skills, and the professional attitude of the graduates. Besides, the ethical, psychosocial, economic, cultural, and humanistic considerations in medicine were priorities; research methodology and technology skills as well as community and population health awareness were also of the key competences expected for the graduates.

If some argue that PBL is a costly experience to implement especially in low-resourced countries and the cost may be bigger on moving from conventional to PBL approach in a school, we, in Suez Canal Faculty of Medicine, were lucky that our school was a newly-developing one. We tried the best use of the available resources: To overcome the space problem and provide more classes for the small group sessions, we divided each classroom into multiple classes by partitions, and we used all the available MOH health care facilities as clinical teaching sites in order to increase the students' awareness about the health hazards and health care delivery systems in each setting, we visited people in every community sites (in country sides, suburban, and urban regions in their homes, factories, elderly houses, maternity and child care centers, schools, day care centers, centers for peoples with special needs, and worked in all cities and villages in Suez Canal region). After preparing the school building with the required equipments for various laboratories including the clinical skills laboratory, the big library, lecture halls, small group classes, recreational sites…etc, then the school opened with 40 students as the first class comparable to other medical schools in the country which used to accept around 1000 students each year at that time.

Admission to our medical school and other medical schools in Egypt has traditionally been administered by the National Arranging Office/Ministry of Higher Education, to which students submit their applications and indicate (in order) their preferred schools they would like to join. Secondary school's scores and the geographic distribution are the main criteria for admission to one school or another. The grades required are the highest for the medical schools in general with only marginal difference between them based on the number of the applying students.

Implementing the innovative curriculum, at the beginning, was not easy and several challenges have been faced; now the school has almost 30 years of proven success with continuing evolving and development. Since then, many other medical schools in both the country and the region have followed us in introducing some or the whole aspects of the PBL approach into the design of their medical curricula.

4. Why Should Curriculum Managers Think about PBL? Some Educational Benefits of PBL

No body can claim that PBL is the magic bullet that will solve all the problems in medical education; however, after 40 years of its implementation in medical schools, PBL did bring many real benefits to health professions' education. If used appropriately, many believe that it could result in several advantages to medical teaching programs. This section will focus on some educational benefits of PBL; first the theoretical benefits behind PBL will be discussed by exploring the effective teaching theories and principles and how can PBL transform these principles into practice, then other PBL learning outcomes will be discussed, and finally, the research evidence that supports or denies those claimed benefits will be investigated.

4.1. Theoretical Benefits behind PBL: From Theory to Implementation

Some argue that the worldwide spread of PBL in medical schools was baseless, and has not been supported by empirical convincing evidence that the approach made much difference from other conventional approaches in terms of the learning outcome [1] However, in terms of the theoretical benefits, others believe PBL was built on strong evidence that it has theoretical advantages and PBL is proved to be a successful systematic attempts to transform the effective learning theories into practical experience [6] and fill the gap between academics and practitioners. To investigate the theoretical benefits behind PBL, we need first to explore what are the approved learning principles and theories in education that guarantee the effective learning experience.

4.1.1. What are the effective learning theories and teaching principles?

The sciences of learning and cognitive psychology tell us that there is nothing more practical than a good theory and by using educational methods and strategies based on strong theories, medical education will become more effective in enhancing the development of knowledge, skills and attitudes of the next generation of our graduates and produce better trained doctors who provide higher level of patient care and outcomes. There is a considerable amount of very useful research on what promotes learning effectiveness and how students learn. The principles that can guide effective teaching practice and facilitate deep versus surface learning can be summarized as follow [24, 25, 26, 27, 28,29], keeping in mind that the points presented, though listed separately, in fact overlap, depend on each other and frequently operate conjointly. The relationships between them are dynamic; they evolve and change with individual learners.

1. **Active learning:** The learner should be an active contributor to the educational process. The teacher is viewed not as a transmitter of knowledge but as a guide who facilitate learning. Students to be involved in mutual planning of relevant methods and curricular content, diagnosing their own needs, formulate their own learning objectives, identify resources to achieve these objectives, carry out their learning plans, and evaluate their own performance. These measures help to trigger internal motivation, give students more control of their learning, and develop students' skills of critical reflection [24].

2. **Real life problems:** Learning should closely relate to understanding and solving real-life problems. This will lead to deeper, more applicable learning, and solidly retained, easily recalled knowledge.

3. **Activation of prior knowledge:** Learning in new situation should consider and activate the current and prior knowledge.

4. **Self-directed learning**: Learners should be given the opportunity and support to self-direct their learning where learning tasks are largely within the learners' control that satisfies personal autonomy and individual choice. [25]. In addition to the mentioned active learning measures, practicing skills that students should do to improve self-directed learning include asking questions, critically appraising new information, identify their own knowledge and skill gaps, and reflecting critically on their learning process and outcomes.

5. **Practice and Feedback:** Learners should be given the opportunity and support for practice accompanied by self assessment, and constructive feedback from teachers and peers. Learning any skill either physical or cognitive require practice with provision of prompt feedback on how well the task is being performed and how it might be improved. Knowing what you know and don't know makes learning more focused.

6. **Reflection:** Learners should be given the opportunities and support to reflect on their practice, this involves analyzing and assessing their own performance and developing new perspectives. *Reflection in action* by actively applying current and past experience and reasoning to unfamiliar events while they are occurring or *reflection on action* by thinking back on what happened in a past learning experience, whether actions taken were appropriate, how this situation may affect future practice…etc. Both kinds of reflection improve learning performance [26].

7. **Learning for transfer:** Knowledge and skills learned in the classrooms will transfer to other situations in the real life practice, that is why providing the students with the opportunities to practice and apply what he has been learned theoretically in other real-world situations is essential for effective learning experience.

8. **Life-Long learning:** In order to cope with the rapid change in knowledge, students should be taught the learning skills as a process, this should be made as explicit as possible to learners, and should be a subject of examination and discussion in and out classrooms. Student reflection about his learning performance should be stressed too.

9. **Role modeling:** Teacher enthusiasm and commitment to teaching and the teacher as a role model have a major impact on the student learning and future educators. Good deal of learning can sometimes takes place by example and through watching a demonstration by an expert, emulating a model and imitating the teacher's performance.

10. **Motivation and engagement (intrinsic V extrinsic motives):** intrinsic motivation (learning for the pleasure of doing and learning) has better learning outcomes. With intrinsic motivation, three basic psychological needs are satisfied by the students, namely, ***autonomy*** that is self-determination; ***competence*** that is the feeling of efficacy that they can do it; and ***relatedness*** which is the presence of support, caring, encouragement of teachers or parents. Intrinsic rewards for learners such as skill mastery, self-development and self-esteem which will flow from the satisfaction of the aforementioned needs will further reinforce effective learning [27].While extrinsic motivations in the form of rewards/punishments – such as gain, pressure, coercion, money, fear, suppresses internal motives and lead to surface learning. The research demonstrates that relative to external motives, internal motivation for learning promotes greater conceptual understanding, better academic performance, stronger feeling of competence, and enhanced creativity [28], while deadlines, directives, threats, pressured evaluations, and imposed goals diminish intrinsic motivation.

11. **Teacher-Learner interaction:** it is the ***quality*** of teacher-student contact, not the ***quantity*** [27] that is of critical importance; establishing strong relationship with students, being accessible, providing feedback to students, caring for the students, their life, various needs and their learning, and getting to know the students both inside and outside the classroom seem to be major factors in promoting student engagement and help instructors to link material to their students' interests and experiences more effectively.

12. **Peer to Peer learning and Student-Student interaction:** [27]. Students are more ready to listen to and learn from their peers than parents or teachers. There is considerable evidence that learning from peers are more effective than learning from formal instruction. Good learning, like good work is collaborative and social, not competitive and isolated. Working with others increases involvement in learning.

Sharing ones' ideas and responding to others' reactions improves thinking and deepens understanding. Teaching activities such as in and out of class discussions, group projects, small group tutorials, explaining learning issues to each others…etc are examples of student-student interaction.

13. **Workload:** very high student workloads seem to be associated with more shallow learning. Reasonable workload is a key even if it means reducing content coverage. Most learners have an upper limit to the hours they can or will commit to study. This limitation should be considered by teachers who may grossly underestimate the cognitive load of a task for students because teachers have much experience with the task that has become automatic for them. A common belief among teachers is that the harder students work and the more they struggle on assignment, the more they will learn (no pain, no gain), such belief is contrary to recent research on cognitive load [27]. Also if new knowledge is to be actively acquired by students, sufficient time must be provided for in-depth examination of the new experience.

14. **High expectations:** Research support the idea that teacher who expect more will get more. High expectations are important for all students regardless their potentials. Teachers should make extra effort to encourage students strive for the highest performance level possible for each individual.

15. **Self efficacy (self determination):** Although may or may not be accurate, self efficacy raises from 4 sources, namely: performance attainment (success raise our self efficacy, while failure lower it), observation of other people (observing other people similar to us performing successfully can strengthen our belief that we can perform similar tasks), verbal persuasion (from a credible source can strengthen us), and physiological state (anxiety and nervousness in difficult situation, not continuous anxiety or stress) are excitements and anticipation rather than ominous sign of vulnerability [29].

16. **Instructional methods:** Characteristics of the instructional approach that promote deep versus surface learning include those that encourage student-centered rather than teacher centered methods, less didactic sessions, setting clear academic goals and standards for the educational course, and highlighting the relevance of what is taught to the future career.

17. **Proper assessment:** There is a significant role the assessment plays on both students' *approaches* to learning and on *what* they learn. Introducing more formative assessment, with the summative assessment, in the course of learning leads to deeper learning and greater retention. Assessment also seems to be more beneficial when it is done fairly frequently, when its tools are valid and reliable, when feedback is provided promptly to help in improving subsequent performances of the students. Assessment fosters deep learning when its goals and tasks are clearly defined and congruent, when task allows student time for information gathering, in depth work,

and reflection. Projects versus exams and collaboration-based tasks versus individual efforts are preferred [27]

18. **Adaptive learning:** students have different learning styles, talents, and motives e.g. visual versus verbal, thinking versus intuitive, reasoning from abstract to concrete versus from concrete to abstract, accommodating versus assimilating, converging versus diverging… etc. Teachers should address this diversity in ways of learning in their teaching contexts. Teachers should know their students, their needs, be flexible, and use diverse methods of teaching; teaching materials; learning resources; and assessment techniques.

19. **Learning environment:** Learning environment that is described as safe, secured, comfortable, caring, trustful, supportive rather that criticizing or blaming, also that finds mistakes as opportunities (not a reason for punishment), transparent, where rules are clear and goals are well defined , where students feel respected and listened to, find intimate teacher –student relationship, where institutional culture encourage collaboration rather that competition between students, where all students are treated equally,…etc, all are associated with more successful learning experience.

Learning experts summarized all effective learning principles in some defined learning theories:

The constructive theory

The primary idea of constructivism is that learners " construct" their own knowledge on the basis of what they already know, this theory posits that learning is active, rather than passive, with learners making judgments about when and how to modify " reconstruct" their knowledge [30]. Learning is a process of creating meaning of the world based on individual experience and interaction [31]. Elaboration (in the form of discussion, note-taking, answering questions…etc) is an example of such activities that enhance constructive learning. Learners should be stimulated to make use of prior knowledge, and to be life long learners. Savery & Duffy [32] mention three principles underlying constructivism. These are: Understanding comes from interaction with our environment, cognitive conflict stimulates deeper learning, and knowledge evolves through evaluation of the viability of individual understanding [32].

The collaborative theory

In collaborative learning, participants share responsibilities and goals. Under this situation, individuals perceive that they can reach their goals if, and only if, the other group members also do so. Students are mutually dependent and need to reach agreements through open interaction to enhance their learning [6].

The contextual theory (a part of Information processing theory)

Knowledge transfer can be facilitated by anchoring learning in meaningful context, for different purposes and from different perspectives [12]. Learners are preferably exposed to a professionally relevant context and confronted with cases or problems from multiple perspectives because this stimulates processing of information and transfer of knowledge. Contextual learning, or *Encoding specificity* refers to the fact that the more closely a situation in which something is learned resembles the situation in which it will be applied, the more likely it is that transfer of learning will occur. *Encoding specificity* is one of the principle aspects of the ***information processing theory*** along with the other 2 aspects (*activation of prior knowledge* and *elaboration*) [33].

The self-directed theory

As mentioned before, Learners play an active role in planning, monitoring, and evaluating the learning process [34]. This is important to prepare the students to become lifelong learners who are able to acquire new knowledge and skills rapidly.

The motivational theory

The theory distinguishes between two types of motivating conditions. *Controlled motivators*: include external rewards: what one should do, incentives and punishment. With controlled motivators, people act under pressure and anxiety, it promotes the form of learning which is rote, short-lived, and poorly integrated into students' long term values and skills [33]. While with Autonomus *motivators*, students engage in an activity simply because it is interesting, relevant, and enjoyable which lead to higher academic achievement.

The control (self- determination) theory

People do things (or learn) to satisfy one or more of five basic needs, which are: Survive and reproduce, belong and love, gain power, be free, and have fun. Any learning experience to be effective should satisfy some of these needs [35].

4.1.2. How can PBL help transform effective learning theories to practice?

Problem- Based Learning is built on most of the above-described effective learning principles. PBL, in the opinions of many education experts, has the potential to prepare students efficiently for future learning because it is based on the modern insights into learning: constructive, self-directed, collaborative and contextual learning theories [6].

The activities in the PBL small group tutorials such as activation of prior knowledge and elaboration (discussion, answering questions…etc) facilitate processing of new information and use of knowledge. Both are key principles of constructive and collaborative learning [36]. Learning in a context, using the integrated approach, group discussion, reflection, , and self-directed process, all lead to cognitive conflicts in students that stimulate deeper understanding, transfer of knowledge, life-long learning and better ability to transform concepts to new problems [37]. Moreover, the PBL learning environment turns students intrinsically motivated.

PBL is a collaborative learning experience*:* PBL group work emphasizes the importance of collaboration between students rather than competition, stresses the win/win rather than the win/fail situation. Students in the small group learn another meaning for success "If one student succeed to achieve all learning objectives but the group fails, this is a failure to everyone". The tutor evaluates the performance of the group work as a team, and how each student share in the group success with a group mark added to each individual assessment schedule. Group develops team spirit which encourages the group member to care about and feel related to the group, because they wish it to succeed [38]. Peer pressure in the group (and Peer to Peer learning) also reduces the likelihood of students failing to keep up with assignment achievement and students enjoy what they are doing in the tutorials. Such environment minimizes pressure while promoting autonomous motivation, stronger feeling of competence, enhanced creativity, and a high level of performance [33].

Using patients' clinical problems as stimulus for learning in PBL leads to contextual effective learning, studies on learning and human memory showed us that contextual learning will enhance better recall and retention of information because the context in which the information is applied closely resemble the context in which the information is learned [39,40].

PBL is an integrated, relevant experience: In PBL, integration of knowledge from various disciplines is fostered. One of the major advantages of PBL is its benefits for basic sciences education [41]; the approach shows the relevance of basic sciences to medicine through the integration of basic medical and clinical sciences in patients' clinical scenarios [6]. While in conventional teaching, basic sciences are delivered to the students in separate nonintegrated discipline-based didactic lectures; evidence showed that not only most of the basic sciences details (taught in the early years) but also the basic fundamental principles are rapidly forgotten by the time the students come to their clinical training and the students don't acknowledge the relevance of these disciplines to medicine [42]. A curriculum that expose students first to animals (in biology and physiology), then to human bodies (in anatomy) and parts of human (in pathology), and only later to live patients is unsatisfactory preparation for a career in medicine. Moreover, the students while enthusiastic when they enter medical school are not interested to choose basic science as a career options but prefer clinical specialties. According to the quality assurance standards, the medical education program should prepare students to all career options. PBL also stimulates the integration of medical and behavioral sciences knowledge in clinical problems which is relevant to the graduate's future professional life. Moreover, PBL helps to eliminate much of the irrelevant non-core factual details and information overload that overburden medical students making PBL a relevant learning approach.

PBL is motivating and enjoyable experience: From the motivational perspective, PBL is more motivating experience because students are more likely to be moved when they see the relevance of what they learn to their future career, when the learning climate addresses self directed learning (students have control on what, how, when they learn) , more personal involvement and more contact and interaction with the teachers and colleagues in the small group sessions also because the faculty/student ratio is higher in PBL system allows stronger personal relationship. PBL is fun and rated enjoyable by both students and staff. One of the most accepted merits of PBL is its ability to motivate students by freeing them from rote learning. Using problems is also motivating to students because they like exploring mysteries.

SUMMARY OF THE THEORETICAL BENEFITS BEHIND PBL

The learning theories and principles that guarantee the effective learning experience tell us that PBL is a successful practical attempt to implement such theories and principles into action and fills the gap between theory and practice. Learning principles like the constructive, self directed, collaborative, and contextual learning theories are best represented in the PBL system. In general, the PBL learning environment turns the approach to an overall relevant and effective learning experience.

Despite the theoretical benefits claimed for the PBL approach, some argue that the educational benefits of any curricular intervention should also include the learning outcomes of such intervention; the following part of the chapter will explore the benefits of the PBL in regard with its learning outcomes.

4.2. PBL Learning Outcomes

Shifting to a new educational strategy requires resources, time and efforts, that is why many asked whether moving from conventional curricula to PBL would be justified. These lead many researchers to examine the effectiveness of PBL against traditional curricula in terms of students' competencies before and after their graduation (Outcome - Based Research).

Although research was not conclusive and in spite of using different study designs (controlled or less controlled trials, cohort, matched comparisons, interrupted time series methods,…etc) of groups exposed and others not exposed to PBL, and despite the presence of different flaws, confounding factors and, interpretations of evidence, PBL was described by many as superior to traditional methods in several students' competencies. The following outcomes were demonstrated in PBL students comparing to students of conventional curricula [43, 44, 45, 46, 47, 48, 64, 65]:

1. Better communication skills and interpersonal relationships.
2. Better humanistic qualities, ethical, and professional consideration of medical practice.
3. Better critical thinking skills and ability to analyze information. Use foreword reasoning process that starts from concrete thought to theoretical idea (from data to solution).
4. Better awareness of psychosocial, cultural, and economic aspects of medicine.
5. Better Life-long learning skills and critical appraisal techniques of available literature.
6. Better utilization of learning resources, resource allocation, literature searching strategies, and more use of library.
7. Better Generic attributes such as management skills: decision making, negotiation skills, problem detection and solving skills, team work, planning, organizing, continuous quality improvement…etc
8. Better preventive medicine and population health awareness.
9. Better in self and peer assessment skills.
10. Better knowledge retention, and recall on facing patients in clinical settings.
11. Better clinical performance and clinical reasoning skills as well dealing with uncertainty.
12. Better awareness about the health care delivery systems in the community.

13. Almost equal performances in National Board Exam (NBE), and US Medical License Exam (USMLE) with graduates of conventional curricula.
14. Have positive attitude toward their teachers.
15. Have high self-confidence, internally motivated, and have high satisfaction with PBL approach.
16. Find PBL as a joyful, stimulating, difficult and relevant learning experience.

Other important desirable outcomes for PBL

PBL is a less-stressful learning experience, a need required for more professional attitude of doctors

To have an enjoyable less-stressful learning experience for medical students is a crucial goal of medical education. If we want doctors to develop good professional attitudes, we have to provide them with the kind of learning environment which is supportive and less-stressful to encourage them to develop such attitude [49]. Nowadays, the prevalence of stress and psychological problems among our students are serious which have a negative impact on their performance. Percentages of students seeking mental health counseling are high, and even higher are the number of students who report they would like to seek such counseling worldwide [50, 51]. Life challenges that medical students must find during their study period such as the challenge of constructing a new social network, having to find a place to live on their own, handle all financial matters, starting a new course of study with different subject matters, vocabularies (in Latin or Greek), and teaching methods that are new for most of medical students. All are considered major life events for young medical students. Environment at conventional universities that is often more indifferent towards the individual student and where the assessment is often more punitive in nature, is adding pressures and stresses on student's shoulders that were enough heavy.

Now, does PBL a completely stress-free experience? The answer is NO, Because secondary school systems are often more traditional which make the shock of transition from secondary schools to university significant, use of student–centered approach and self-directed learning in PBL is usually stressful for students, at least for their first year of medical school, and require quite some time getting used to. However students admitted afterwards that they prefer working in the PBL learning environment and enjoyed their experience with the PBL system .

PBL helps graduates to deal with information explosion

The volume of medical information that is presently available to undergraduate medical students is enormous and it continues to expand at an exponential rate. Since we are drowning in data (but seeking for information), live in the era of super-specialists where the knowledge mass doubled very quickly (one can't catch up) and half of what students learn today will be proven wrong after 10 years; therefore, learning skills and self-directed learning are considered vital requirements today in the field of medicine. On adopting PBL, we teach students the learning skills needed for life-long learning without compromising the essential required fundamental basics in medicine that every doctor should know, students also learn critical appraisal techniques that help them evaluate any given new information rather than stuffing students with huge amount of knowledge that is nonessential for practicing medicine and that leaves no time for teaching other needed competencies,

PBL prepares the doctor of the future

PBL is seen as a valuable response to many pressures for change in medical education; in many experts' views, it can help in preparing the tomorrow's doctors. The rapid change in medicine, education, and the characteristics of the new generation of medical students urge all who wok in the medical education field to support the educational systems that satisfy the novel needs. Features of these rapid changes include medical schools intake that has expanded; often students are older at entry, students work under more life stresses, students have higher levels of expectation, entitlement, self-esteem, and even narcissism than students in previous decades; they prefer educational approaches that stress multimedia content, demand less reading, and allow greater flexibility on the part of the student [52]. Currently, more teaching is devolved to non-physicians, medical practice is increasingly influenced by economics and global health, graduates work shorter hours with less on-the-job training, but care for people who live longer, experience more co-morbidity and receive poly-pharmacy [53]. Besides, many doctors work in other countries far from where they received their medical education, and where population health aspects, medical hazards, and health care delivery systems may widely differ. Doctors has to face the explosion of the scientific knowledge and literature, and they make greater use of electronic resources, not only for information and learning, but also for consultation, records, treatments, and follow-up. They face many other diagnostic and management challenges with the rapid advance in newly-available diagnostic and therapeutic procedures. Moreover, there is a current attention to cultural and ethical issues in medicine reflected in the increasing concerns and complaints about poor communication skills of doctors that are raised to medical regularity authorities [54]. All these novel changes should drive medical schools to do the necessary equivalent modifications in their curricula to cope with these changes and attain the current needs. Yet the skills to meet the rapidly evolving modern practice are barely acknowledged in medical schools' programs.

Next generation of doctors need to have training focuses on many neglected professional aspects; to enable students to provide best practice throughout their careers, medical schools should prioritize the teaching of skills for self-directed, lifelong learning: particularly evidence-based practice and computer literacy [53]. More concern should be given to critical thinking skills, communication and management skills, cultural and socioeconomic awareness; and other professional development skills. Given the globalization of medicine and the more stress in the students' life, medical schools should encounter global medicine in their programs and emphasize a less-stressful, pleasurable medical education experience.

To address the needs of medical students for future practice, the General Medical Council (GMC) in UK has specified 300 standards for undergraduate education and behaviors in two reports. The first [55], *Medical students: professional values and fitness to practice* was published in 2009 as guidance for medical schools and medical students. The guidance relates to: 1- the professional behavior expected of medical students. 2- the scope of students fitness to practice. The second report [56]: *Tomorrow's Doctor*, an update, is expected to be published later in 2009. It demonstrates all the outcomes hoped for the doctors of the future as well as some recommendations for the educational program; the standards of professionalism, safety, and diversity are central.

Besides GMC's "*Tomorrow's Doctor*" standards, other medical students' expected competencies have been recommended by other medical education-concerned organizations:

1. In 1999, the American Council for Graduate Medical Education (ACGME) the accrediting body for individual residency programs in USA endorsed six competencies as a direction for outcomes-based model of professional development [57]. These six core competencies – patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice – were initially intended for residency training programs but have since been adopted by undergraduate programs across the United States.
2. The CanMEDS 2000 Project in Canada identified the multiple roles that must be fulfilled by physicians: expert, communicator, collaborator, manager, health advocate, scholar, and professional [58].
3. The Association of American medical Colleges (AAMC) Medical Student Objectives Project concluded that physicianship could be broadly categorized under the competencies of knowledge, skill, altruism, and duty [59].
4. The University of Dundee in Scotland has used a three-circle model of competence that focuses on what the doctor does, how the doctor approaches practice, and the doctor as a professional [60].

In the following, the *Tomorrow's Doctor* Standards will be presented in some details as an example of the medical students' expected competencies:

Some of the "*Tomorrow's Doctor*" standards include the following [56]:

General rules

It is for medical schools to design their own curriculum to suit their own circumstances. Modern educational theory and current research must inform both curriculum design and delivery.

Students must have different teaching and learning opportunities that should balance teaching in large groups with small groups, practical classes and opportunities for self-directed learning

Students should wherever possible learn in a context relevant to medical practice, and re-visit topics at different stages and levels to reinforce understanding and develop skills.

The curriculum will be structured so as to integrate the learning of basic and clinical sciences, enabling students to link theory and practice.

Expected outcomes: stressed the requirements of different roles played with the future doctors.

1. The doctor as a scholar and a scientist:

Apply psychological and social principles, method and knowledge to medical practice.

Apply population and improvement science principles, method and knowledge to medical practice.
Apply scientific method and approaches to medical research.
(a) Critically appraise the results of relevant qualitative and quantitative studies as reported in the medical and scientific literature and understand the ethical and governance issues involved in medical research.

2. **The doctor as a practitioner:**
Carry out clinical reasoning skills in consultation with a patient.
Make clinical judgments and decisions based on the available evidence, in conjunction with colleagues and as appropriate for the level of training and experience. This may include situations of uncertainty
Communicate effectively with patients and colleagues in a medical context

3. **The doctor as a professional:**
Behave according to ethical and legal principles.
Know about and comply with the ethical standards including *Good Medical Practice.*
Reflect, learn and teach others.
(a) Acquire, assess, apply and integrate new knowledge and learn to adapt to changing circumstances.
(b) Establish the foundations for lifelong learning and continuing professional development, including a professional development portfolio containing reflections, achievements and learning needs.
Learn and work effectively within a multi-professional team.
Demonstrate awareness of the role of doctors as managers, including seeking ways to continually improve the use and prioritization of resources.
(a) Utilize resources effectively to balance patient care, learning needs, outside activities.
(b) Allocate finite health care resources wisely.
(c) Work effectively and efficiently in a health care organization.
(d) Utilize information technology to optimize patient care, life-long learning, and other activities.

The recommendation for the medical schools is to prioritize teaching these skills that are needed for future practice and enable their graduates to provide best practice throughout their career. It promises for PBL graduates that they are doing well in these high –priority areas; PBL seems to address the previously-described outcomes that are often overlooked in conventional curricula and has the potential to prepare students more effectively for future learning and practice because it underscores many of these needed competencies expected for the tomorrow's doctors [6].

Summary of the PBL learning outcomes

Many learning outcomes have claimed for the PBL system: besides the improved students' competencies in various learning domains, PBL is considered as s a less-stressful experience and helps graduates to deal with the information explosion in the field of medicine. Overall, PBL help prepares the doctor of the future by improving medical students' expected competencies recommended by the (GMC), (ACGME), (CanMEDS 2000 Project), (AAMC), and other medical education- concerned organizations.

The question now what does the research tell us about the theoretical benefits and the learning outcomes of PBL? Does the research support or deny such educational benefits?

4.3. PBL efficacy and the research evidence

Theory (process)-based research and Outcome based research

Several review studies about PBL have been appeared in the literature since early 1990s till date. Earlier research was concerned about the theoretical advantage behind PBL **(Theory or process-based research).** However, the outcomes movement that seized the educational world by storm urged the researchers in medical education to focus on the outcomes of the learning processes. In the USA [59], Canada [58], the UK [61], and elsewhere [62], medical education-concerned organizations and accreditation bodies are demanding that medical schools, in establishing its curricula, have to justify their efforts in terms of educational outcomes demonstrated in the graduates' performances [63]. So, recent literature (since 2000) concentrated on measuring the outcomes of PBL in comparison to other conventional curricula **(outcome-based research).** The **process-based studies** assessed how PBL transformed the effective learning principles such as the constructive, self directed, collaborative, and contextual learning theories into educational practice and how different variables influence the efficacy of PBL as a successful educational approach. The process-based research revealed clearly that PBL is a successful systematic attempt to apply the science of learning and cognitive psychology into effective learning experience [6]. The **outcome-based research** aimed to answer the question whether moving from conventional curricula to PBL, as a major curricular intervention with its required cost, is worthy and justified; review studies have appeared in literature aimed at examining the effectiveness of PBL against traditional curricula. The results have been a subject of considerable interest and debate. Although the research is still inconclusive (some studies delivered positive effects, some negative effects and others found no difference in the compared outcomes), there is good evidence and agreement that the PBL method delivers on some very important issues [64].

4.3.1. (Theory) Process-based research

Systematic review studies

The PBL systematic review studies concluded that PBL stimulates students toward effective learning observed in the constructive, collaborative, and self-directed learning, and proved the theoretical claims for the PBL. The earlier review studies also revealed that both students and faculty are satisfied by the PBL teaching principles. Norman and Schmidt, 1992 [65] concluded on reviewing the evidence for the theoretical advantages for PBL that there is a strong theoretical basis for the idea that PBL students maybe have better ability to use and retain knowledge, self-direct their learning, and transfer concepts to new situations as a result of elaboration and activation of prior knowledge stimulated in the PBL tutorial group discussion. These skills are content-specific, accompanied by acquisition of knowledge, and not just content-free learning skills. Another review by Albanese and Mitchell [66] examined many studies conducted between1972-1992; the authors concluded that both students and teachers are very satisfied by PBL principles as a way for teaching. Two other reviews supported the same findings [67, 68].

Other designs - studies

Several other sporadic studies have been performed to test the same hypothesis (if PBL has built on sound learning theories). The studies have provided empirical evidence that PBL is a good model to implement the learning theories needed for any effective learning experience, the theories which are supported by the experts of learning science and cognitive psychology such as the constructive, collaborative, motivational, self-directed and contextual learning theories [39, 40, 69, 70, 71]. They showed that PBL enhance intrinsic interest in subject matter and is more enjoyable and help students to elaborate on their knowledge, induce cognitive conflict, and use other effective learning techniques which improve processing and restructuring their knowledge base. Cooperation also is reported to improve the quality of the problem solving in PBL students than did competition [72]. Blumberg and Michael [73] reported that PBL move students towards wider utilization of learning resources and frequent use of the library to access information and borrowed more materials.

Process-based research also assumed that PBL is a complex learning environment in which different process-related factors may act together or individually to influence PBL efficacy, many studies have tested the role played by such variables in the theoretical advantages hoped for PBL, examples of these studies include what is done by Van den Hurk [74] who tested the relationship between quality of learning in PBL students and their achievement, and found that in-depth reporting in tutorial session, making summaries and explaining concepts to other students led to deeper understanding. The tutor role also was a subject of many studies, the findings are often contradictory, some found that content expert (who has experience with the studied problems) is better as a tutor than non-expert and in other studies the opposite finding is shown. Schmidth [75] concluded that content expert tutors are better able to deal with courses that are less structured ad fit less with students' level of prior knowledge. Dolman et al [76] conducted a study in which demonstrated that tutorial groups with relatively low level of productivity require much more input from a tutor than highly productive groups.

4.3.2. Outcome-based research

The move to 'evidence-based' practice, particularly within medicine, has led to attempts at reviewing the efficacy of PBL as a teaching practice in comparison with other teaching and learning styles in terms of students' competencies. In general, the research is still inconclusive. Several review studies have appeared in the literature.

Systematic Review studies

Two systematic reviews were done in 1993, but these reviews found more similarities than differences in outcomes, particularly in licensing exam scores, among graduates from problem-based learning and traditional curricula. Moreover, there were some indications that graduates of problem-based learning curricula were more caring and compassionate than graduates of traditional curricula [66,67]

Colliver, in a review conducted in 2000, [46] analyzed eight studies in the period 1992-1998, three of which were randomized and five were non-randomized to compare curriculum tracks. The author concluded that the literature didn't provide enough evidence of the effects of PBL. Findings of this review are similar to the earlier reviews conducted in early 1990s [66,67]. Colliver found that, in terms of knowledge and by using national licensing exams as outcome measure, PBL students perform a little better or a little worse than students in conventional curricula. The results also showed PBL is unlikely to make students learn more knowledge in short term (although PBL may foster over a periods of up to several years increased retention of knowledge as shown by Norman and Schmidt) [65]. Colliver added that, on measure of clinical performance and problem solving, students from PBL showed better performance (slight but significant effect) and on measure of student satisfaction, students of PBL were more satisfied with their learning environment. The author concluded that the literature, so far, revealed no convincing evidence that PBL improve knowledge and clinical performance, at least not of the magnitude of effectiveness hoped for with this major curricular intervention [46].

Another review conducted by Newman and colleagues [77] on behalf of Campbell Collaboration (the collaboration that established the electronic database of systematic reviews of the effects of educational interventions, the equivalent to the Cochrane Collaboration for evidence-based interventions in health care). The authors, in this review, identified 91 papers (included in 5 previous reviews), but based their conclusion only on 14 studies. Only the randomized trials and quasi experimental studies were included in the review if the student performance and other outcomes are objectively measured in several tests for PBL students comparing against a control of other conventional curricula. The results of the systematic review varied from advantages for PBL in some measures such as study approaches and satisfaction, and advantages for conventional curricula in terms of accumulation of knowledge. Based on these 14 studies, the authors concluded that the outcomes for students of PBL groups were less favorable than those in the control groups.

Dochy *et al.*, 2003[78] in their recent meta-analysis, they selected 43 articles; the authors found non-robust evidence that PBL had negative effect on knowledge possession, but robust evidence that the method had positive effects on students' knowledge application. The conclusion was there are a positive effect from PBL on skills (knowledge application) of students and no effect on knowledge content.

Koh and colleagues, 2008 [43] given the widespread recognition of the importance of ethical and cultural competence in medicine and the recommendations to emphasize such issues in medical schools' curricula [79], they assessed the effect of PBL on such competencies on students after graduation (unlike previous reviews that studied students before graduation). Koh and colleagues [43] did find differences in outcomes in just the place where they hoped. Compared with graduates of traditional curricula, graduates of problem-based learning curricula was better in social and cognitive dimensions. They had better diagnostic and communication skills and a greater appreciation for the cultural aspects of care and legal and ethical issues in medicine; PBL students demonstrated greater responsibility and were better able to cope with uncertainty [43]. The findings indicated a strong level of evidence against problem-based learning in terms of graduates' self-assessments of their possession of medical knowledge; graduates of problem-based learning curricula assessed themselves as possessing less medical knowledge than graduates from the control group, however, supervisors generally found little difference between the 2 groups. The authors also didn't find any differences in outcomes for PBL graduates based on the country of study, however, the number of studies from each country was too few. Koh et al [43] concluded that PBL during medical school has positive effects on physician competencies after graduation, especially in the social and cognitive dimensions.

Other designs- studies

Other sporadic studies assessed various outcomes of PBL

To explore the long term effects of PBL, one study [80] conducted by Cohen-Schtanus and colleagues, examined 2 cohorts from the same school; participant students were admitted to medical curriculum in 1992-93 at the Faculty of Medicine, University of Groningen, the Netherlands and comprising graduates of a PBL and conventional curriculum. In this study, graduates of the PBL curriculum scored higher on self-rated competencies, graduates of the conventional curriculum needed less time to find a postgraduate training place, and no differences were found between the two groups for scientific activities such as reading scientific articles and publishing in peer-reviewed journals.

In another study conducted by Norman *et al.,* 2008 [63], the authors concluded that no evidence that graduates of PBL confers any advantage in terms of maintaining competence over decades from graduation, although the authors built their conclusion on a quite small PBL sample to the control group (108 students versus 857) and although the outcomes were measured by peer rating and by delivered cause of concerns to the authorities [63]. Another study assessed the use of learning resources in students of different curricula by Blumberg and Michael [73]; they reported that PBL students make more frequent use of the library to access information and borrowed more material from the library than students involved in a traditional curriculum.

Schmidt *et al.*, 2009 [81] assessed the impact of PBL on graduation rates in 10 generations of Dutch medical students, the results showed that PBL curricula are successful in retaining students, the authors explained the findings by the fact that PBL enable social contacts through small-group active learning which leads to better learning environment and academic achievement, and subsequently decrease the dropout rate. Moreover, PBL students needed less time to graduate and graduated in larger numbers than students from conventional curricula [81].

Antepohl and colleagues, in a trial to predict the doctor performance outcomes based on the type of curricular intervention, the authors found no evidence that McMaster's students, who learned the principles of evidence-based medicine during their undergraduate careers, were better able to keep up with the literature (82). Others showed the effect of PBL on performance outcomes is scarcely visible in performance at the time of graduation [83,43].

Summary of the PBL research evidence's results

Despite the discrepancy in the results of the outcome-based research, there is an agreement that PBL does introduce something new versus conventional curricula based on reasonable evidence. First, PBL does provide a more challenging, motivating and enjoyable approach to education [33]; second, there is a higher level of student satisfaction with PBL;

third, there is no differences in knowledge levels; and fourth, PBL students have better interpersonal competencies, communication skills, and ethical and social awareness and commitment which positively affect the quality of their interactions with patients [84, 85, 82,43]. These favorable outcomes are added to what has been proven by the theory-based research that PBL stimulates constructive, collaborative and self-directed learning and constitutes a successful trial to bridge theory to practice. Other outcome-based review studies, however, showed no convincing evidence that PBL improve knowledge or clinical performance at the magnitude of effectiveness hoped for with this major intervention.

5. What Are the Debatable Issues about PBL?

As any approach, PBL has both advantages and disadvantages; however, PBL effectiveness and research constituted a subject of considerable debate in literature, the extreme support of the PBL by its strong believers has led to opposition and tough defenses from the conventional teaching supporters. It is understandable why both sides act on such aggressive and assertive way. PBL side are happy because they finally found a less-stressful, enjoyable learning experience with almost equal outcomes with the conventional approaches, however change brought fear at the opposite side. Fear that because of this innovative approach in education, we may lose control over the fixed traditional perspectives of the missions and outcomes of medical schools, the educational role of the teachers as well as the identity of the medical profession. The debate is healthy and is needed in order understand each others, to collect new ideas, to identify our needs, and to continuously improve our performance. However, as too many words has been said and too much arguments have been flared, we feel that it is time for all of us, who concern about medical education, to go forward, and to work together for the benefits of our graduates and our served patients; it is time to stop pointing fingers, blaming each other, and just searching for other side's mistakes.

The aim of exploring the debatable issues, in this chapter, is not to stand with or against any approach or to stoke the flame of division, the aim to investigate the whole situation from various angles and explore the points of disagreement between both sides and to Look inwards for the truth of the debatable strength/weakness points in both teaching systems, and to identify our needs seeking for a common ground to stand on and to construct a new perspective in curriculum planning and development that considers the best of both strategies and that stresses the necessity of a continuous, dynamic, evolving curriculum development process to serve the ever-changing needs of students and patients as well as the health care systems and our societies.

As no body can claim that PBL is the magic bullet that will solve all the problems in medical education, it is also oversimplification to view the PBL as an educational strategy that merely produces graduates with some learning and humanistic skills and it is also illogical judgment to describe the conventional curricula as no more than a rote learning experience which is devoid from other desirable outcomes. After years of debates about the relative merits and weaknesses of problem-based learning, finally everybody agrees that there is good evidence that the method delivers on some very important issues [1]. As Albanese, 2000 [33] has mentioned " Perhaps the most compelling evidence of PBL doing something has been the rapid spread of PBL within and beyond the health profession and the presence of the rabid supporters of PBL and the excitement that PBL has generated in the educational communities" "…. It induces an intensity that is analogous to a religious fervor" Albanese said [33].

Despite the agreement between the opponents and advocates of PBL that the approach has introduced some favorable changes in medical education, still there are some points of disagreement. These points are either about the effectiveness and efficiency of PBL or about the integrity of the PBL educational research. In the followings, various debatable views will be explored then the current research needs in the present stage will be discussed.

5.1. Debatable Points about the PBL Effectiveness and Efficiency

1. The PBL outcomes may be seen as somewhat disappointing for medical educators who support the conventional curricula. They find the outcome is not impressive enough to justify the cost of changing to a new educational perspective with the needed resources, time and efforts. More human resources are needed in the form of more staff to work as tutors in PBL classes (staff/student ratio is 1:8 to 1:10 Vs 1:15 to 1:17 in conventional curricula). Moreover, PBL requires competences many teachers don't possess; Staff Development Programs should be employed to overcome this obstacle. Implementing PBL also require more rooms for the small group tutorials, more learning resources such as electronic technologies and well-prepared library that is accessed by large number of students simultaneously.
   Others can argue that even if the PBL strategy has no effect on acquisition of knowledge or clinical skills, If PBL is just an enjoyable, less-stressful experience that improves the learning climate and produces more compassionate, communicating graduates with high humanistic and social skills? Is it worth the efforts? The answer is YES, it is a worthwhile goal in and of itself. Moreover, PBL is not necessarily more expensive to implement than a conventional curricula. To overcome the need for recruiting more tutors, PBL can be delivered through student-led PBL groups which have shown almost equal performance with faculty-led tutorials. The big halls can be divided into multiple small classes. Some modification for the process may be introduced such as problem based lectures, or problem based independent learning…etc
2. Some may find the theoretical basis for PBL is week [46] and PBL is a passing fad introduced by educationalists who are out of touch with the reality of teaching.
   Others may respond to this saying no, there is a forty years history of PBL with proven success; PBL is taking advantages of the conventional curricula all over the world. The theoretical basic principles that PBL is built on, are considered as compulsory quality standards and requirements for the accreditation of the medical schools' educational programs according to the Liaison Committee for Medical education (LCME) [86] and the World Federation for Medical Education (WFME) [87] and other standards [56, 57, 58]. The PBL principles that include self-directed learning, collaborative learning, using problem-solving as trigger for learning , and apply learning theories such as the contextual, constructive, motivating, and reflecting learning theories into practice , the principles that stress the acquisition of

life-long learning skills and outcomes such as improving communication skills and, , socio-cultural consideration, and the ethical and professional attitudes , all are required as essential quality standards for accrediting the medical schools' programs.

3. The waste of teacher's experience and the tutor who can't teach is a concern raised by teachers who have experienced only a teacher-centered approach, enjoy passing on their own knowledge, and they can perform better only in the conventional situations, they feel that their role as information provider is threatened and PBL facilitation is difficult and frustrating.

   It is understandable why the teachers of conventional curricula feel in this way. Resistance to change is often expected especially from those who feel comfortable and take advantages of the old circumstances, or who mistrust and doubt the efficacy of the change which may constitute a threatening and more demanding approach to them. It should be acceptable to all of us that the student can learn without the presence of a teacher but the teacher can't teach without the students, Teachers should be reassured that the student-centered approach will not eliminate the role of the teacher in the educational process, it just modifies this role. It is better for both the students and teachers to adapt to the new roles. In addition, facilitating PBL tutorials is only one of a number of other teacher's roles in the PBL system. The teacher is also a subject matter expert and a valuable learning resource outside the PBL class; teacher's roles as student's assessor, curriculum developer and evaluator, role model, mentor, administrator, researcher, study guide developer and learning resources creator, course planner, community server…etc are some other essential roles beside the teacher as an information provider or facilitator in either the PBL or conventional curricula.

   Moreover in the PBL sessions, tutor is not just a silent man, the students value the experience of the tutor in the PBL, they need him/her to provide them with valuable feedback driven from his/her experience and they want a tutor who can realize when the students are not on the right track in their student-directed process and redirect them back. Students also show more commitment and better performance in the presence of the experienced tutor in the PBL class.

   Additionally, teachers in PBL curricula play a vital and critical role in the success of the whole educational process, they are very influencing on students by supporting, reassuring and directing them in the new system, and having teachers who strongly-believe in the value of the PBL approach is a very crucial requirement to ensure the success of the PBL experience in any location. If the teachers don't trust and support the method, they will be a source of great confusion for the students.

4. Some may say that the knowledge content is not improved in PBL and the basic fundamentals of the disciplines may be lost. Moreover, the students give more focus on the clinical details and the non-core versus the core content knowledge. Some may feel also that PBL is a threat to basic science education and constitutes a challenge to teach some basic sciences such as anatomy. They argue that PBL-students have less academic achievements in basic sciences and a narrower knowledge base. They claim also that the future credibility of the medical profession is threatened by cloning it by service-based doctors or graduates with some learning and humanistic skills instead of visionaries and experts to preserve the infrastructure of the profession.

Others may respond to these blames by: it is known to everybody that the aim of introducing the PBL in medical curriculum was not to improve the knowledge content. In contrary, the aim is to deal with the information explosion and the too many irrelevant, forgettable, un-utilizable factual details taught in the conventional curricula that use up the whole available educational time at the expense of teaching other important competences. The aim of introducing PBL is to give only the required essential information and basic principles that the newly- graduating doctor should know for practicing medicine not for passing exams. At the same time PBL approach aimed to teach students the learning skills and critical thinking and appraisal techniques that enable them to be life long learners and to cope with the enormous amount of information in the field of medicine. PBL is a method of learning aimed at more retention and better recall and application of knowledge rather than at a bigger amount of knowledge; and overall, the approach succeeded in accomplishing these aims.

Second, although PBL students assess themselves as lower in basic sciences compared to students of conventional curricula, there is a good evidence that PBL students has almost equal performance in terms of the knowledge content of the basic sciences measured by various exams as USMLE and measured by their teachers' rating [78, 43].

Third, according to the quality assurance standards, the undergraduate medical education program should provide general professional education to prepare graduates for the subsequent phases of their training and to expose them to all career options [86, 87]. The aim of undergraduate medical education is not to produce visionaries at this early stage of professional life. The graduates still have long time of learning in the post graduate phase to master the needed skills and fill any gaps.

5. Given the volume of medical information that is presently available to medical students, some may think that PBL students will be unsure how much self directed study to do, what information is relevant and useful, and students may have trouble determining just how to link related concepts in a useful scaffold of applied knowledge. Moreover, students may evoke many factual errors and focus on irrelevant details in the PBL tutorial sessions. As a result, the students may experience anxiety as they conduct their self-directed learning and may acquire more unfocused content at the expense of the core significant knowledge.

   Hence, some may argue that while the ability to conduct self-directed learning is a skill that all medical students will need throughout their professional careers, it is important to provide students some guidance in the early stages of their learning. In the PBL tutorials, students perform, think, get involved, learn by trial and errors, the tutor although should allow students to learn by doing some mistakes, his/her role specially in the early years is to help students to help themselves by trying to discover these mistakes by asking them questions, raise points need to be considered, challenge their thinking, and redirect the path of the session if it goes to unfocussed direction. As an information source, tutor may infrequently respond to direct inquiry without sacrificing the self- study value and after being sure the students' own thinking and information are exhausted and feeling that his/her information will facilitate further work with the problem, and without which the students may walk in a wrong course. That is why tutors with content knowledge are more helpful especially for PBL students in their early years.

The guidance to students in their self-directed learning, can also take the form of well-constructed self learning modules (SLMs) [88,89] to help students learn how to acquire and organize newly-acquired knowledge, link related concepts, and apply this new understanding at an appropriate level of factual detail within the context of realistic clinical scenarios.

6. Some raised the issue of forward versus backward reasoning and criticize the critical thinking process of PBL students where they use hypothetical deductive mode of reasoning, namely: from concrete thought (data, observation, phenomena, signs, symptoms) ***To*** abstract thought (solution, theory, fact, diagnosis); for e.g. in PBL , the student think : “The patient has chest pain with radiation and diaphoresis, so the likely diagnosis is heart attack”, a forward reasoning from symptoms to diagnoses versus “ It might be a heart attack because the patient has chest pain, radiation and diaphoresis”, a backward reasoning from the diagnosis to the manifestation. In this regard also, in conventional teaching the teacher start the lesson by the fact then its application or the disease definition then its clinical manifestation and diagnosis. Some think that this reasoning process in PBL students may lead to collecting and exploring too much un-needed or un-focused data by the students, either during their learning process or later in the clinical settings, which lead students astray.

   Others may respond to this by: First, according to studies of expertise both within medicine [90] and in other domains [91], this form of thinking, from data to solution has been identified as the hallmark of expertise. It is also consistent with the admonition to medical students to `gather all the data', `be systematic', `don't do pattern recognition' and `avoid premature closure' - that is, to avoid having tentative diagnoses guide search [92]. PBL forward reasoning is the mode of thinking that help students acquire the clinical reasoning skills needed for starting their professional practice, while the backward reasoning is more suitable for more experienced doctors. On facing patients, less-experienced doctor has to collect data from patients, analyze, organize, and evaluate these data, focus only on relevant clues, discard the big amount of irrelevant data given by the patients, find links, define the problem, recognize the needs for more information and diagnostic measures and then arrive at a diagnosis. If the students are familiar with this process by long practice in PBL sessions, it will be easier for them, in the clinical sittings, to perform the whole process in less time and on the subconscious level. In clinical sittings, the PBL students will just do what they had been doing with similar problems in their PBL tutorials, and that is why PBL students show better clinical reasoning and diagnostics skills than graduates of conventional curricula. Second, the forward reasoning as an educational approach is preferable because it leads to more solidly retained information, and facilitates the recall of the retained knowledge on facing patients in real life situations and also provides the opportunity to think about various differential diagnoses and decreases the possibility of misdiagnosis.

7. One of the challenges that face the curriculum wide implementation of PBL is that the curriculum delivery system should be centrally governed due to its interdisciplinary nature. Since many medical schools are primarily governed by

departments, a centrally governed curriculum often conflicts with the governance of the medical school.

Resolving that conflict is no small problem [33], that is why implementing PBL into medical curricula has better chance to succeed in newly-opened schools that can adapt more easily to any new strategies; also accepting the need for strong administrative, governance and institutional support to insure the co-ordination between all departments and staffs, is a fundamental requirement.

Summary of the debatable points about PBL effectiveness and efficiency

The debates focused on the disadvantages of PBL as seen by the conventional curricular approaches' supporters: The high cost of the PBL, the waste of teacher's experience and the tutor who can't teach, the strength of the learning theories that PBL is based on, the students' knowledge content that is not improved by the PBL, the students who are less qualified to direct the educational process, the critical thinking and reasoning process of the PBL students that is doubted, and the logistic challenges that interfere with the implementation of the PBL in the medical schools; all are issues of controversy regarding the PBL effectiveness and efficiency.

5.2. Debatable Points about PBL Educational Research

Most PBL debatable issues are about the educational research, the integrity of the studies conducted to assess the effectiveness of PBL, the validity of the studies' results; and the research needs at the current stage.

The big debate on research in PBL resulted in part from the current move to structure evaluation efforts toward "what we produce" rather that "what we do" and the subsequent tendency in research to compare PBL with conventional curricula in the "outcome-based research", the trend that is criticized by many experts. Moreover, the debate was a result to the discrepancy of the findings of various studies and also was due to the state of fear and mistrust between the PBL advocates and opponents.

The raised points during the PBL educational research debate

1. **Poor research quality:** In a systematic review conducted by David Cook et al, 2007 [93] to study the quality of reporting the experimental studies that assess the outcomes of educational interventions in medical education, they found these studies generally poor. Although the authors didn't use a systematic comprehensive search strategy, given the difficulties and limitations associated with identifying medical education research using existing databases, many essential elements of scientific reporting were frequently absent from 105 articles describing medical education experiments, this included poor critical literature review, conceptual framework, study design, definition of the comparison or control group, and acknowledgement of human subject rights.

2. **Study design: PBL experimental trials flaws:** Some [6, 92, 94] argue that the experimental controlled trials may not be the appropriate research design for evaluating the outcome of the multi-factorial PBL intervention, and educationalists should not be driven by the pharmaceutical companies-minds in conducting educational research to evaluate curricular interventions' outcomes. Some experts see the educational research as the hardest science of all; therefore, experimental trials in education are often criticized for its methodological flaws. In education, there are seldom clear solutions to complex problems, so randomized or un-randomized controlled trials will be unlikely to help much because it is impossible to attribute success or failure solely to the intervention when there are may other interfering factors. Experimental trials of curriculum level interventions in the outcome-based research are a waste of time and resources in some opinions because there is no such thing as a blinded intervention, neither a pure nor a uniform intervention in such experimental studies [92]. In the view of Norman and Schmidt," Trials of curriculum level interventions, whether they show large, small, zero or negative effect sizes, whether they are or are not randomized, whether they are done on large or small samples, whether they are of sound or unsound methodology, are a waste of time and resources" [92]. They are waste because, by their very nature, they are doomed to examining one variable, or more likely an unspecified combination of many variables, at a time. We may, if we are fortunate, conclude that a particular intervention, administered to a particular sample, to teach a particular content, using a particular outcome, was successful. But we will have no way of determining the generalizability of the findings of these experimental trials to a different situation [92].

   Experimental study by definition is a prospective study in which researchers evaluate a well-defined variable (intervention or independent variable) to assess its impact on other (dependent) variables (95). In biomedical research and in terms of the strength of evidence, the experimental randomized controlled trial (RCT) are on the top of the Evidence-based Pyramid and considered as the best study type (after the systematic review or meta-analysis that comprehensively analyze and qualitatively synthesize information from multiple well-designed trials), however the 4 pillars of RCT, namely the randomization, blinding, allocation concealment, and drop-out control are impossible to fulfill in educational research (as it will be detailed later in this chapter). Given these challenges, educational experiments, in literature, are not limited to the classic randomized trials, but embraces the entire spectrum of weak and strong experimental designs [96,95], including single-group, post-test only studies, static group comparisons, and non-randomized or quasi experimental studies added to the randomized trials:

   post-test only studies (assessment carried out only after the intervention)

   pretest / post-test studies (assessment carried out both before and after the intervention) were distinguished

   randomized study: study groups were assigned randomly

   quasi-experimental non-randomized study: study groups were assigned using a non-randomized method

   matched-group study: study groups were systematically assigned by matching participant characteristics

static-group comparison study: groups were pre-existing, formed for non-study purposes
single-group study: a single study group .

A well-conducted, high quality experimental trial require many items to consider, most of these items are over-looked, or difficult to attain in trials that assess the PBL outcomes and that is why some argue that it is a misunderstanding of educational research to think that randomized experiments are the only ones that yield trustworthy evidence especially on assessing curricular intervention like PBL [97, 98]. Therefore, criticism is given to the outcome-based reviews because of their strictness in including only studies in which conventional and PBL curricula are compared. Also, the Best Evidence Medical Education (BEME) movement is criticized; BEME is the collaboration that involves an international group of individuals, universities and organizations; it committed to moving the education of physicians from opinion-based to evidence-based education. The goal of the BEME movement is to provide medical teachers and administrators with the latest findings from scientifically grounded educational research to provide a basis for informed decisions. The collaboration is also criticized for stimulating randomized, controlled experiments, particularly trials of curriculum-level interventions, as the recommended approach to construct trustful evidence in the educational domain [99].

According to the CONSORT checklist (of items to consider on conducting a randomized trial) the following items are required to ensure the internal and external validity of the experimental studies' results, to control different variables and confounders within the compared participants groups, and to provide an overall sound empirical evidence; these items are either missed or ill-performed in the PBL outcome-based studies:

Selection of the participants: randomization, blinding, allocation concealment, and methods used to generate the random allocation sequence all should be mentioned clearly to avoid various sources of selection bias. These items are very difficult to commit to in educational research, thus, selection bias is one of the major flaws in medical education research and volunteer bias is one of these errors that are pointed out in the work of some researchers (as it will be shown in this chapter).

Study participants: The base-line characteristics for the students participated in both the tested and control groups of the study should be shown in details. These characteristics should also be considered when analyzing the collected data by doing subgroup analysis and adjusted analysis for various variables as for sex, age, personality character…etc. This is important for the generalizability of the results since the characteristics of students in deferent studies widely vary.

Sample size: should be enough to abstract valid results, also the ratio between the tested and control group sample sizes should not exceed the range of 1:1-1:4, otherwise it will affect the accuracy of the extracted results. Many educational trials don't consider this point in their methodological procedures.

Intervention: Precise details of the intervention intended for each group, how and when they actually administered are also needed. Neither PBL nor conventional curricula are only one thing. If the intervention and control are not clearly and completely defined, then the results – regardless of their statistical significance or effect size – will be un-interpretable.

Outcome measure: Clearly defined primary and secondary outcomes and methods used to measure these outcomes should be described. In PBL research most studies used outcomes measures involved perceptions, attitudes, self-ratings and opinions, not measures of educational effectiveness such as measures of knowledge and skills [46]. These used measures are limited in reliability and validity, subjective and prone to rater biases [43].

Data Analysis: The estimated effect size and its precision for each outcome should be calculated during the analysis process of the collected data. An effect size refers to the difference between two (or more) treatment means (usually experimental group vs. control group) divided by an estimate of the standard deviation. In PBL research some reported outcomes have small effect size, so there is a big argument about how much effect size is enough to account the findings. The debate raises the issue of whether effect sizes of less than 0.80 have been found to be useful [33].

Interpretation of the results: should take into account the sources of potential bias as well as the dangers associated with multiplicity of analyses and outcomes; general interpretation should be in the context of the current evidence by its unique characteristics and limitations (locality, definition of the used interventions in the tested and control groups, students characteristics, presence of co-interventions, confounders, or various sources of bias such as, selection bias, performance bias, detection bias, drop-out and detection bias). Also, all limitations of the study should be clearly described by the authors in order to help the readers extract valid interpretation of the findings.

Without the above considerations, it is impossible to generalize or to make broad statements about the global superiority or inferiority of PBL compared with conventional methods. There are three reasons summarized by Norman and Schmidt [92] why educational trials in PBL outcome-based research are ill-founded and ill-advised: There is no uniform intervention, there is no pure outcome, and here is no blinding. Looking at these items in details we can recognize other reasons for educational research errors and why do these studies lack the quality standards, and additional debatable points:

More reasons for PBL educational research errors

3. **No uniform intervention, no pure outcome:** As previously-mentioned, there are too many ways to define ‘PBL’ and too many ways to define ‘conventional’ teaching formats. Since PBL has a number of characteristics, it can be implemented in very different ways in various places. PBL is individualized, cooperative, small group, with expert/non-expert tutors, self-paced…etc. As a consequence, any study that treats PBL as a single intervention' and examines the usual cognitive and clinical outcomes will arrive at a conclusion of minimal difference [92].

4. **Variables, Confounders, Validity Threats:** There are many variables, confounders, and co-interventions or validity threats in the educational research that interfere with the measured outcomes and limit the ability to generalize the PBL outcome research findings. In these complex and multi-factorial environments, effects are inevitably diffused by a myriad of unexplained variables and turn the outcome-based PBL research studies as subject to biases and confounds that plausibly account for the findings and undermine confidence in the conclusions of those papers [46]. These confounders have to be adjusted to (during the data collection and analysis) although, as Geoffrey Rose (1926—93) has said "You can adjust for the confounders you know about, not for the ones you don't" [100]. Confounders that we know about can arise from differences in participants (addressed by research techniques such as random selection and assignment) and contexts (addressed by conducting or replicating the study in, for instance, more than one institution); however, in experimental PBL research, an equally (if not more) important potential confounder is the intervention itself [101,102]. In comparisons of different instructional designs, the designs must vary by only one element within (and not between) levels [103]. For e.g. it will be useful to assess the outcome of PBL in 2 compared groups of PBL students in the same institution, almost similar in their baseline characteristics and differ only in one variable such as having expert v non-expert tutor, male v female sex, use structured v non-structured problem, or have availability of learning resource vs. limited resources,….etc. These studies (process-based research) may provide us with more meaningful findings about why and when PBL produce positive/negative outcomes and under which condition, and avoid the biases resulted from the PBL intervention variables on comparing PBL to conventional curricula.

Now what are these PBL intervention variables which may influence various educational outcomes of the approach and can be considered as success/failure factors?

PBL Intervention variables (PBL success/failure factors)

(a) **Problem:** The structure of the problems, which are used as trigger for learning, can influence the end outcome of the PBL approach. E.g. too well-structured, too close-ended, and too simple problems will not challenge students to construct knowledge actively [6], while contrasting real life problems structured to stimulate prior knowledge, fit with the prior knowledge and contains sufficient cues to stimulate discussion is important to avoid the ritual behavior in the tutorial group and lead to more effective learning [3].

(b) **Tutor:** Too directive, dominant tutors hinder the learning process, but the quiet or passive tutor who is probably trying not to teach also hinders the learning process. In both situations, PBL cannot be characterized as self-directed [104]. Tutors who believe only in the teacher role as an information transmitter not as a facilitator of the student-centered learning process have negative effects on learning in the PBL sessions, while the ability to stimulate active, self-directed, contextual and collaborative learning has a positive effect on the use of problems. In order to stimulate students towards self-directed learning, there should be a transition from tutor regulation, or external guidance through shared guidance in which the student and the tutor together guide the learning process to student regulation [105,106]. The best tutor knows when and how to intervene and has the students' learning as his top priority [107]. Content expertise, effective tutoring skills and other characteristics of the tutor may also play a role in the outcome of the educational process.

(c) **Group function:** Dysfunctional PBL tutorial groups can take many forms and have negative impacts on the learning process and outcome: E.g. Apathetic groups, groups cynical about PBL not discussing problems, groups with passive tutors, and group with ritual behavior where cognitive activities such as elaborations and activation of prior knowledge do not take place; also the very small or very big size of the group, lack of cohesion and lack of motivation; all can highly inhibited the learning process and outcome in a PBL system [108, 109,3 , 32, 110, 111].

(d) **Learning resources:** The availability and use of either primary resources (i.e., resources that students were instructed to study) or supplementary resources (i.e., resources that students were oriented to study when there was time available) may affect the PBL outcome. Students show good performance when courses offer more learning resources and when students consult diverse sources of information and own skills for identifying, accessing and using learning resources in an effective way [112, 113]. However, the progressive reliance on students' skills to select sources of information has been suggested to lead to adverse effects that may come from extreme views of self-directedness expected from students in PBL [113]. Besides, the negative influences of increasing amount of resources on students' motivation are to be seen [64].

(e) **Learning environment and institutional culture:** if the learning environment stimulates students towards constructive, self-directed, and contextual learning; if the PBL approach is implemented where the institutional culture supports the team work spirit and the collaborative rather competitive values among students, and encourages the safe, democratic, and challenging environment, as it enhances the intimate student/teacher relationship; if the culture respects the value of accepting the constructive critique and adopts the principles of continuous quality improvement; the probability to obtain a successful PBL experience would be expected.

(f) **Assessment strategies:** In order to help out the process success, learning and assessment should be better integrated, which implies that assessment design, instruments, and formats to be compatible and consistent with the PBL educational strategy and the used learning principles in the school. If the assessment process relies solely on factual recall and discipline-based assessment, PBL may appear less attractive to students and students may be less enthusiastic to participate in the PBL process. Different institutions which adopt PBL, however, use different assessment strategies, objectives, tools, and methods in both theoretical and clinical assessments; this include (but not limited to) the belief by some that assessment in the form of summative exams may interfere with the adult learning principles and internal motivation. Moreover, replacing the students' scores with pass/fail remarks, in some opinions, decrease the stress raised by comparing students'scores and emphasize viewing the exam just as a tool to show students if they are on the right track. These variations, and others, in the student assessment may have a consequence on the educational success of the PBL system.

(g) **Students' Selection criteria for admission to PBL School:** Students' personality traits such as persistence, self directedness, cooperativeness, self-transcendence and internal motivation were identified to be positively associated with intrinsic academic motivation and better performance in medical students [12, 115]. Other criteria that can influence the PBL outcome may include the students' background knowledge and the previous education level and type, the students' admission scores in preceding scientific courses, as well as other professional attitudes and behaviors.

(h) **Faculty experience, attitude and beliefs toward the approach:** Faculty experience with the PBL and their willingness to dedicate their time and effort to implement PBL; also, the quality of the faculty development programs (especially for the newly-recruited teachers) and on job training (for clinical/non-clinical teachers) on various roles of the medical teacher, to help faculty members understand and apply the method effectively, are vital needs for the process success.

(i) **Governance, institution, and administration's support:** Governance and administration support to the adopted PBL strategy is crucial requirement for better achievements of the PBL system. It facilitates conquering the logistic challenges faced in implementing the approach and encourage the coordination between different departments in the school for better integrated work.

(j) **Central coordination and organization:** coordination and organization between different courses and various departments (including the coordination between clinical and theoretical teaching courses). Also density, content, and structure of the courses and the overall comprehensive curriculum design and management, all can influence the process and play a role in the PBL progress.

On conducting research studies that aim at assessing the outcome of PBL, the previously-described variables should be taken into consideration during various phases of the conducted study starting from the study design, methodology, data analysis and interpretation of the results, in order to provide an accountable valid conclusion which relates the outcome of the study to the intended exposure by its exclusive characteristics.

Beside the presence of different variables and confounders in educational PBL intervention research, the followings continue the reasons for flaws and errors in the PBL outcome-based research:

5. **No Randomization, blinding, or allocation concealment in PBL educational research:** Randomization, blinding, and allocation concealment, all are impossible to

satisfy in experimental educational research to assess an intervention like PBL, therefore, most intervention studies in medical education (and in social science) are nonrandomized, or quasi-experiments, but again there is an argument about the efficacy of the quasi experimental research design. Quasi-experimentation, by definition is compromised methodologically [116], it is done where pre-selection and randomization of groups is difficult, they lack random allocation of groups or proper controls, so firm statistical analysis can be very difficult. Whilst regarded as unscientific and unreliable, by physical and biological scientists, the quasi experimental method is, nevertheless, a useful method for measuring social variables [117]. In the opinion of others, without proper randomization, statistical tests in these studies can be meaningless. The quasi-experimental designs do not take into account any pre-existing factors, or recognize that influences outside the experiment may have affected the results. Disadvantages aside, as long as the shortcomings of the quasi-experimental design are recognized, these studies can be a powerful tool, especially in situations where "true experiments" are not possible [117]; they are very good way as a preliminary step to obtain a general overview and then to be followed up with a quantitative randomized experiment, to focus on the underlying reasons for the results generated. Colliver et al, 2008 [116], in defending the reputation of medical education research, showed in their article that the problem in the educational experiments is due to the incomplete and uncritical use of quasi-experimentation that don't rule out threats to validity posed by the methodological flaws.

6. **Volunteer bias in medical education research:** Many studies [118, 119, 120, 121] aimed to examine the demographic and performance differences between research volunteers (e.g. students who give permission for the collection of data from their postgraduate training directors to allow their data to be used in outcomes research) and non-volunteers who are targeted by researchers, but decline to participate, refuse to provide research data or refuse permission for the collection of data on their behalf. The differences, between volunteers/non-volunteers, were to the extent that the some authors [118] recommended that student consent to participate in medical education research should not be a requirement in the research that aims to obtain unbiased evaluations of educational interventions' outcomes. The authors found significant difference that can jeopardize the quality of the collected data. The difference was found in the personal attributes, women and minority groups were less likely to volunteer, non-volunteer were more likely to report a history of physical and mental illnesses, and non-volunteers showed poorer performance on cognitive tests compared with respondents. Besides, the undergraduate performance in science courses (but not in non-science courses) showed higher scores in volunteers compared to the non-volunteers [118]. The finding was significant enough to urge the authors to propose that educational research protocols to be exempt from the IRB (Institutional Review Board) submission which oversees the ethical issues related to protecting the welfare of the research participants. Hence, the recommendation is to differentiate between the IRB's evaluation process of the clinical research and that of the educational research and more rigid criteria for participation are to be imposed in

clinical research because of the possibility of serious health risks in these studies compared to the minimal risk expected in educational research.

7. **The systematic review and meta-analysis Flaws:** Systematic review and meta-analysis conducted to evaluate available literature on PBL effectiveness also have some flaws. Many of the search-yielded articles in these reviews were excluded by the authors from the final analysis without strong justification, and this interferes with the accuracy of the collective results and exposes their findings to the selective reporting bias. Also the literature search, sometimes, is not comprehensive enough to include major search engines and the grey literature (given the limited databases available for educational research), which is needed to avoid the publication bias. Besides, some educational researchers may duplicate their results on the same done work in more than one published articles; including these duplicated articles in the systematic review or meta-analysis leads to errors in the collective and quantitative results of the systematic review and the meta-analyses. Moreover, the subgroup analysis (to adjust for the confounders), sensitivity analysis (quality assessment of the included studies to exclude poor quality ones), and heterogeneity assessment (to detect the heterogeneity level between included articles) all may be neglected or not well-conducted in the systematic reviews and meta-analyses of the PBL research. Furthermore, by definition, the meta-analysis is a systematic review of literature conducted to abstract collective quantitative data from group of studies that have the same research design; given the variability in the methodological designs, qualities, and outcome measures in the included studies, it is impossible to abstract a collective data under a title of meta-analysis from such widely-variable studies. Colliver et al, 2008 [116] re-examined meta-analyses on PBL and found meta-analyses are commonly performed on quasi-experimental studies that were subjects for biases and confounds. In addition to this, threats to validity were not ruled out in the individual studies, nor in the meta-analysis itself. They illustrated concerns about the validity of the meta-analyses and conclude that the field of medical education might be better served in most instances by systematic narrative reviews that describe and critically evaluate individual studies and their results in light of threats to their validity rather than by conducting quantitative meta-analyses.

Summary of the debatable points about PBL educational research

The debate focused on the challenges that face the research in medical education in general and specially the studies which aimed to assess curricular interventions, such as PBL, in education; those challenges which interfered with the integrity of the available evidence and resulted in poor quality medical education research in literature: The reasons of difficulties and flaws in conducting experimental, quasi-experimental, systematic reviews, and meta-analyses studies in medical education, were encountered in the debate. The sources of various biases including selection bias, intervention bias, volunteer bias, detection and reporting bias which jeopardize the internal and external validities of the research findings were major debatable points.

5.3. Current Research Needs in Medical Education

There is a need for other research perspectives in medical education research specially the research that assesses curricular interventions such as PBL; this may include:

I. Qualitative research rather than quantitative research

Increasing criticism has been given to the objectivistic view of sciences (which now seems to be emphasized by the BEME movement) versus qualitative decisions and trained judgments needed to make sense of the objective findings. This criticism is raised because objectivity in the form of simple description of nature as it appears is not really a scientific method; one must judge, decide, and critique the objective results to get the most benefits of it. Besides, science includes more than simply dealing with methods [122]. Some experts believe that medical education is too complex, too local, and too subjective to be reduced to analysis by those interested only in quantitative approaches and outcomes [123].

Qualitative research is strongly recommended by some medical education editors and researchers who doubt the value of quantitative research in assessing intervention outcomes in education and have reasons to mistrust quantitative approaches to assessing their work although they would agree that much of their published research would benefit from being more scientifically and theoretically rigorous [124, 125, 126].

II. Mixed methods research

Using a mixed methods approach, where qualitative and quantitative techniques are combined, is becoming increasingly popular in health sciences education research [127]. Some find mixed methods research deserves an increased presence and recognition in medical education research for its anticipated benefits. Indeed, under the right circumstances, a mixed methods approach can provide a better understanding of the problem than either quantitative or qualitative research approach alone especially when studying new or complex initiatives and interactions in medical education [128]. Although both quantitative and qualitative methods have distinctly different philosophical roots [129], the challenge therefore, is to create a design that provides the optimal combination and sequence of both approaches.

III. Narrative research

Dolman [122] and other authors suggested the need to use narrative research as different methodological perspective in educational research beside the statistical meta-analysis and quantitative reviews. Narrative research is a popular approach in qualitative research; it is a collection and analysis of stories [130] and a technique includes asking service users to recount their experiences in their own words. The narrative research gathers informal stories (often from staff) as part of a wider ethnographic study, with conscious and explicit use of storytelling techniques as part of action research. Some argued if narrative research should be looked at as a real research, and when should the collection and analysis of stories be classed as research and how should we judge the quality and appropriateness of such research [131]. Experts think that the aim of narrative research is not necessarily to determine a 'true' picture of events, but rather to explore such things as how the individual has made sense of these events, their attitude toward them, what meanings the events hold for them, and how these feelings came to be. Recommended quality guidelines should also include that, narrative research must meet the general criteria of high-quality research.

IV. Observational versus experimental research

Observational research is a non-experimental quantitative form of research that is also needed to be focused on in medical education. Observational studies are considered as the experiments of nature where the independent (tested) variable is not under the control of the researcher. In biomedical science where the randomized controlled trial is seen as the gold standard for research, in medical education this rule is not literally applicable [123].When aiming to assess the outcome of an educational intervention, we have to assess what is actually going-on on the ground in the real, natural situation rather than in an experimental or artificial environment; so observational studies such as (well-conducted) prospective or retrospective cohort designs, or case control studies my sometimes constitute more powerful analytic evidence than experimental research in education. Recently, in medicine, the observational studies versus RCTs have raised an issue of argument; medical researchers recognized the risk of selection and volunteer bias and the socioeconomic difference in experimental studies' participants from those in observational studies, the difference which sometimes endangers the quality of the results (e.g. the conflicting results between observational studies and randomized controlled trials on the effects of hormone replacement therapy on coronary heart disease, the difference was related to socioeconomic factors). Some raised a recommendation to develop guidelines for improving the quality of observational studies in medicine [132], and this is what moved several international groups, including Cochrane Collaboration to develop guidelines for assessing non-randomized intervention studies and to consider designs other than the experimental studies as a an accountable research evidence. And this is also what we need to do in medical education research, to emphasize the observational studies as a respectable strong evidence for evaluating various curricular interventions and to establish the required guidelines to ensure the high quality of these observational studies.

V. Process-based research versus outcome-based research

An intense debate has emerged between different viewpoints (of theorists and program evaluators) about the appropriate research that can lead to development of knowledge relevant to guide decisions in medical education and can show the exact efficacy of the PBL approach. Should the appropriate required research be process-based studies aimed at examining whether the theoretical constructs of PBL work in practice; and how and why PBL succeed/ doesn't succeed in certain place, or should the appropriate research be large trials of curriculum-level interventions comparing PBL and conventional curricula's outcomes. Some experts believe that we should not only focus our research on the effectiveness of educational interventions, the weakness of these studies is that they do not focus on the theoretical claims behind PBL, due to which they do not provide us with better insights into why or why not PBL might work [6]. These experts think that there is an agreement now about the change the PBL succeeded to introduce to medical education in terms of some important , previously overlooked, students' competences; and now the next step is to answer the questions of why the method works and under which condition and what is the active ingredient in PBL [1].

Examples of this process-based research may include studies that investigate the effects of interaction between different PBL variables: Does the process of working in small groups help problem-based learning graduates acquire better communication and interpersonal skills? Is it the problem-based learning curricula typically have more input from professionals, such as social workers and psychologists, who may be more concerned about physicians having a better appreciation of the cultural, legal and ethical aspects of care? Is the curriculum itself more likely to contain objectives that better prepare graduates to cope with uncertainty? Such questions need to be answered so that the potential benefits identified can be incorporated into the curricula of other medical schools [1].

Questions that are also raised in this regard are: Is it really the outcome of an educational approach that matters and can justify the process? What if stress, fear, anxiety, boring, and tension lead to good students' performances and desired outcomes, can these outcomes justify the whole suffering? What about the secondary outcomes and the adverse events of any intervention? Are both students' and patients' needs thought about in our decisions of which curricula to adopt in our medical schools? If the students and staff are satisfied by the PBL as an educational approach and see it as an enjoyable, less-stressful, relevant experience; and if the patients prioritize the importance of the skills, which are proven superior in PBL graduates such as communication skills and professional attitudes in the performance of their doctor of preference (the best doctor in the patients' view is the one who listen to patients [133]), doesn't this mean anything to the curricular planners in medical schools? Isn't the quality of any service mean satisfaction of the customers' needs? Isn't the purpose of the medical education to meet the health care and society needs taking into account among other things the current changes in the medical field and the changing roles of health care professionals? Then, why don't we listen to our customers and the society raised concerns? The move to outcome-based education doesn't mean to focus only on the product not the process; it doesn't mean that how we teach is not important; indeed, the total quality management of any job has to include the 3 essential elements of the implemented job (input, process, and output). In this regard, if the PBL system has strong theoretical background to reassure us it is appropriate for the task and if the evidence proved some advantageous outcomes, why don't we follow these positive findings with more PBL process-based research to improve the outcomes and learn from mistakes and why don't we conduct more studies to explore the strength/weakness points and the success/failure factors in PBL as well as in different curricula instead of wondering who to blame the theories or the program evaluators?

VI. PBL and Basic sciences research

Since the PBL strategy has been less challenging for clinical departments than for departments of basic science, where it has often evoked anxiety, opposition, lack of cooperation, and general mistrust, we need to investigate the detailed influences and various impacts of PBL on education of different basic sciences and if these influences are the same with each discipline; we need to know if the education of certain basic sciences get benefited from PBL philosophy than others. We need also to examine the utility of scientific knowledge in a medical curriculum, the utility which means the quality or state of being useful of such basic medical knowledge in medical practice, is important to examine in order to establish some ground rules for what should, and should not be studied by medical students. We need to explore the best teaching strategies, methods, and tools that should be used in teaching various basic sciences to enhance the value and sustain the adequacy of basic sciences education in medical schools.

VII. Improving the peer reviewing process of medical education research

Some critiques were given to the peer-reviewing process of medical education research articles and how the quality and value of medical education research are assessed. Commentators frequently argue, with some justification, that medical education research is often judged by criteria that may be inappropriate. They wonder if medical education research should be viewed as a part of Biomedical Science family (with its strict, tough reviewing guidelines and extensive use of quantitative methods which don't comply, in most cases, with educational research) or as a Social Science (with lenient reviewing approach and softer nature of many of its methodological approaches). In UK, medical education research is viewed as a medical science rather than a social science, and it will be classified, there, within one of the three new medical science categories according to the REF (Research Excellence Framework) [134], therefore, medical education research will be subject to the new bibliometric analysis rather than the lighter-touch approach proposed for the humanities, social sciences and mathematics. This view of medical education research as a branch of a medical science not a social science needs to be widely applied by the scientific community.

Moreover, and based on a systematic review that highlighted the poor quality and major deficiencies in most published experimental medical education research [93], the authors called for an international assembly of editors and authors to define reporting standards that can enhance the scientific validity and ethical integrity of the medical education research. However, authors' guidelines provided by the journals alone will probably be insufficient to ensure reporting high quality articles in medical education; evidence suggests that both the peer review and editing processes have the best chances of improving reporting quality [135, 136, 137, 138, 139]. In terms of the credibility or constructiveness of the reviews provided by various journals' reviewers, editors of medical education journals admit (probably to no-one's surprise) that there is heterogeneity in the field; most of the reviewers gave high caliber reviews and exceptional critiques, other reviews make it clear that there are some people working in the field who have never been taught how to perform a peer review [140]. So, editorial boards of the journals of medical education research must have the obligation to ensure the integrity of the reviewing process and do their best to run the process as an efficient, professional and constructive manner. Attempts to improve the peer review process is important because better reviews mean better papers, which implies a stronger evidential and theoretical basis on which to build our practice improvements. Editors should not allow any paper that doesn't signify a strong empirical evidence and fulfill the quality standards to be published in their journals. The questions now are: what are the qualifications of good reviewers that turn them eligible for such job? Should we view the reviewer only as a representative for the target audience? The database of the potential reviewers as a whole is constituted of people who work in the medical education and medical education research communities [140]; or should the reviewers also have mastered skills in the evidence-based techniques, critical appraisal skills, research methodology expertise, awareness about the ethical considerations in research that protect human participants, and other skills? Some may find statistical skills are not a must requirement in the peer reviewers; however the manuscripts should be assessed by a statistician for the integrity of the statistical analysis used to make benefit of the collected data.

In addition to this, the quality of a scientific journal must not be assessed based only on its impact factor or the number of citations of its published articles which can be manipulated easily and comprises a misleading parameter. Instead, quality of the reviewers and integrity of the reviewing process as well as experts' and readers' assessments should be of the essential parameters according to which any scientific journals to be evaluated and not only the number of citations, since the high impact factor (as we recognize in the literature) doesn't guarantee high quality of the journal's published articles even in biomedical research journals which must implement a very strict evidence-based rules in their reviewing process.

VIII. Ethical consideration in medical education research

We need to take into account the ethical consideration in educational research; we need to discuss the protection measures of the human subjects in research of health professions' education with its three basic principles: autonomy (informed consent), beneficence (risk/benefit ratio), justice (if students are considered vulnerable subjects when used by their professors in research) and the requirements for the IRB submission of the educational protocols.

IX. Centers for medical education research and development

We need to train the researchers in medical education on how to conduct high quality research in this field and various challenges that face the research in education. We need to Create and sustain centers for medical education research and development in our universities with a specific mission to provide scientifically sound information for use in advancing understanding of medical education and the research in this field and provide evidence-based support to making decisions about particular educational alternatives [141]. These centers should also provide the professional consultations for researchers who conduct medical education research. The faculty staff of these medical education centers should include not only doctors with MD degrees or with expertise in biomedical research, but also the presence of people experienced in social and behavioral sciences research (its designing and methodology, and data analysis tools such as technical expertise in psychometric measurements), will be of greater help.

X. Solving the problem of the publication bias

We need also to solve the problem of the publication bias. Concerns remain that studies that are not published alter the collective understanding of the research results; traditionally, results have been publicly disclosed by seeking publication in peer-reviewed scientific literature, but there are well recognized limitations. Not infrequently, researchers find difficulties in publishing their conducted studies in peer-reviewed journals for different reasons; many journals accept only 15% of the submitted manuscripts for publication. We need to make the best possible efforts to ensure that the results of all studies are available in the public domain in ways that help inform decision making in medical education. To overcome the publication bias, research quality which guarantee valid and significant results (either positive, negative, or no effect of the exposure on the outcome) should be the only parameter (not other considerations) according to which the manuscript to be accepted or rejected by the journals' editors. Some suggestions may also include when it is not possible to publish studies in a peer-reviewed journal because of space restriction, publishing only the results summaries is a partial solution and ensures that results are in the public domain whether or not they are accepted for publication [142]. Moreover, publication and presentation at scientific congresses are often limited to those who attend the congress or who have access to conference proceedings. Additional steps such as including these congresses publications into journals or major search engines and databases would be valuable to make results presented in these meetings more widely available.

Conclusion of the current research needs

Instead of relying on outcome-based experimental studies that compare PBL to conventional curricula and that proved difficult to answer the question of "which curricular delivery method is superior" because the answer will always be: 'It depends': It depends on the topic, the objectives, the learners and many other variables. Thus, we need new aim for our research work; better research questions would be: 'When and how should we use a particular delivery method? What are the unique strength/weakness points in different curricular approaches beside PBL? What are the success/failure factors for each system?" We need other forms of research studies; we need more qualitative research, logical arguments, mixed methods studies, correlational analyses, and cost-effectiveness information [103]. Process-based research is needed to assess how different variables act together and individually and its impact on the outcome of PBL. The real conundrum is to find out why the agreeable effects of problem-based learning were observed at all [1]. We need also studies that closely examine different impacts of PBL on basic sciences' education and what are the best teaching strategies to sustain the adequacy of teaching various basic sciences. We need to improve the methodological quality of our experimental/ non-experimental studies, to report more details about the educational interventions that are being compared and more information about the context in which the study was conducted, and generally to consider various sources of potential biases in medical education studies. We need more observational research to evaluate the situation on the real ground, new guidelines are needed also to improve the quality of these observational studies. Besides, we need new rules and procedures for the peer reviewing process of the educational research to ensure the integrity of this process in the medical education peer-reviewed journals. Merit of the peer reviewing process should be one of the parameters according to which the quality of the scientific journals is evaluated. We need to take into account the ethical consideration in educational research, and to respect the protection measures of the human subjects in our studies and discuss the IRB submission rules of the educational protocols. We need a consensus if medical education research should be considered as part of biomedical or social science class and which guidelines suit better for the validity of research in education. There is a need also for hyper-reflection in conducting and reading medical education research. We need to train the researchers in medical education on how to conduct high quality research in this field and various challenges that face the research in education. We need to construct and maintain centers for medical education research and development in our universities to help provide scientifically sound information for use in our decision makings and to support other researchers in the field with the needed technical expertise. Moreover, we need to solve the problem of the publication bias and to make the best possible efforts to ensure that the results of all studies are available in the public domain in ways that help inform decision making in medical education. Publishing only the results summaries is a partial solution if the space restriction limits the whole text publication in peer-reviewed journals, including congresses' publications into journals or major search engines and databases would be valuable to make results presented in these meetings more widely available, editors' acceptance/ rejection parameters for any research study should be based only on the quality and significance of the study results. Indeed, researchers, reviewers and editors should channel their enthusiasm into getting the methods and findings of research right, rather than letting it directly drive their decisions and conclusions [46] because anything less than thoughtful and informed research carries the further risk of misdirecting the literature and damaging the reputation of education research as a field [143].

Finally, we need to listen more for our students and our patients (as well as other stakeholders) as service users and end-costumers of the medical education profession. We need to investigate their opinions and study their perspectives about which educational strategies can successfully satisfy their needs and how the appropriate doctor should look like as what does high quality medical education mean to them.

At last, if we really want the research in medical education to help evaluate the real circumstances in the medical education field and assist in the continuous quality improvement of this profession as to facilitate judgeous decision making in regard with various curriculum interventions in medical schools, immediate enhancement measures to improve the current situation of the research in medical education should be taken into serious consideration by all who work in the medical education career and its research in order to attain the aims we look for.

6. What Is the Role of the Quality Assurance and Accreditation Programs in Standardizing the Educational Processes in Medical Schools?

Answering the question of "what is the definition of high- quality medical education?" is difficult. If we surveyed the medical educators to answer this question, some may believe the answer would be: "It is the sort of medical education that medical teachers seek for their own children, if they were medical students." Quality of medical education can be also defined by the sort of education that produces graduates who are fit for the purpose. Various accrediting bodies and organizations concerned with the quality of the medical education profession have settled many standards to ensure high quality service in medical schools or to help those schools accrediting their educational programs. Now, should these quality assurance standards involve and describe clearly the type of the educational process and teaching strategy that must (or should) be adopted by the medical schools which are seeking out for accreditation?, or should the standards give more focus on the outcomes of the schools and the sort of graduate the school produce? And what is the exact role of the medical schools' accreditation programs in standardizing the educational processes in these educational institutions?

The Liaison Committee for Medical Education (LCME) [86] is the nationally recognized accrediting authority for medical education programs leading to the M.D. degree in North American medical schools. Accreditation by the LCME is required for schools to receive federal grants for medical education; most state boards of licensure require that U.S. medical schools be accredited by the LCME as a condition for licensure of their graduates. Also, the eligibility of U.S. students to take the United States (USMLE) requires LCME accreditation of their school. Beside the LCME in North America, the World Federation for Medical Education (WFME) [87] is the global organization concerned with medical education and training of medical doctors as well as undergraduate students; both organizations launched quality standards, the purpose of which was to provide a mechanism for quality improvement in medical education to be applied by institutions responsible for medical education, and in programs throughout the continuum of medical education in order to gain the accreditation of these institutions' programs[86, 87]. The purpose of the accreditation process, in general, is the recognition of medical courses that produce graduates competent for training in any branch of medicine and with appropriate foundations for life long learning and for proficient medical care [144]. The launched standards cover many areas within the institution: 1) Mission & Objectives, 2) Governance & Administration, 3) Academic Environment, 4) Educational Program, 5) Students, 6) Faculty/Staff, and 7) Resources.

The educational program is examined within the accreditation process from four different facets:

Objectives
Structure and Content
Teaching and Evaluation
Curriculum management

If we thoroughly examined the standards established to ensure the high quality educational program, we could recognize that they are unfortunately broadly set in terms of the educational strategy adopted by the school and didn't specify obviously the sort of teaching approaches to be implemented. Instead, the accreditation process and standards respected the autonomy of schools to choose its own teaching system and allows for different profiles and developments of the individual medical schools; indeed, the accreditation process and standards settled by most accrediting bodies and quality-concerned organizations suggest broad and flexible guidelines, and acknowledge the difference between countries. For example, the WFME defined its standards as global standards with necessary national or regional specification and according to the WFME, the international standards settled the following general rules [87]:

Only general aspects of medical schools and medical education should be covered.
Standards should be concerned with broad categories of the content, process, educational environment and outcome of medical education.
Standards should function as a lever for change and reform.
Compliance with standards must be a matter for each community, country or region.

The standards established under Teaching & Evaluation Section of the educational program [87] state that "the school to specify the type of teaching and evaluation methods best suited for achievement of its settled educational objectives". This means that, as long as the school defined clearly its educational program's objectives (of knowledge, skills and attitudes the students are expected to acquire during their studying years), then its up to the school to choose the educational strategy or the teaching approach the school authority believe is the best to achieve the school objectives. However, WFME quality assurance measures [87] stated some general features that can guide the school decision of which teaching strategy to adopt, of these:

1. Given the necessity of changes and innovation in medical education, the structure and process of medical education programs should be reconstructed in order to:
   Prepare doctors for the needs and expectations of society.
   Cope with the explosion in medical scientific knowledge and technology.
   Inculcate physicians' ability for lifelong learning.
   Adjust medical education to changing conditions in the health care delivery system.
2. The medical school must define the curriculum models and instructional methods employed. The curriculum and instructional methods should ensure that students have responsibility for their learning process and should prepare them for lifelong and self-directed learning.
3. The medical school must teach the principles of scientific method and evidence-based medicine, including analytical and critical thinking, throughout the curriculum.
4. The curriculum and instructional methods should be based on sound learning principles.
5. Curriculum models would include models based on discipline, system, problem and community, etc.
6. The medical school must identify and incorporate in the curriculum the contributions of the behavioral sciences, social sciences, medical ethics and medical jurisprudence that enable effective communication, clinical decision making and ethical practices.
   Instructions must enable students to gain communication skills needed to communicate effectively with patients, patients' families, colleagues and professionals.
   The behavioral and social sciences and medical ethics should provide the knowledge, concepts, methods, skills and attitudes necessary for understanding socio-economic, demographic and cultural determinants of causes, distribution and consequences of health problems.
6. Basic sciences and clinical sciences should be integrated in the curriculum; integration of disciplines would include both horizontal (concurrent) and vertical (sequential) integration of curricular components.
7. Program must provide general professional education that prepares students for all career options.

In addition to the WFME standards, the LCME standards [86] also didn't state a specific sort of teaching strategy which should or must be implemented (or to what extent) in medical schools, so the accreditation standards were of little help in solving the current dilemma about which strategy constitutes a higher quality- approach or which system is recommended to use. Instead, the general features of the educational program settled by LCME stated the following:

1. The medical faculty must design a curriculum that provides a general professional education, and fosters in students the ability to learn through self-directed, independent study throughout their professional lives.
2. The curriculum must incorporate the fundamental principles of medicine and its underlying scientific concepts; allow students to acquire skills of critical judgment based on evidence and experience; and develop students' ability to use principles and skills wisely in solving problems of health and disease.
3. The curriculum must include current concepts in the basic and clinical sciences, including therapy and technology, changes in the understanding of disease, and the effect of social needs and demands on care.
4. The curriculum must include behavioral and socioeconomic subjects, in addition to basic science and clinical disciplines.
5. Curriculum must have instruction to prepare students for their role in addressing the medical consequences of common societal problems such as substance abuse, violence…etc.
6. Students must learn gender and cultural biases ad racial difference in themselves and others.
7. Students must demonstrate understanding of the manner in which people of diverse cultures and beliefs perceive medicine.
8. There must be specific instruction in communication skills as they relate to physician responsibilities, including communication with patients, families, colleagues, and other health professionals.
9. Medical schools must teach medical ethics and human values, and require its students to exhibit scrupulous ethical principles in caring for patients, and in relating to patients' families and to others involved in patient care.
10. There must be evaluation of problem solving, clinical reasoning, and communication skills.
11. There must be comparable educational experiences and equivalent methods of evaluation across all instructional courses.

From the above description, it is recognized that although neither the WFME nor the LCME mentioned clearly if the schools to adopt lecture-based or problem-based system as the main educational strategy, they both agree that the purpose of the medical program accreditation is to provide assurances that the graduates exhibit general professional competencies that are appropriate for entry to the next stage of their training, and that serve as the foundation for life-long learning and proficient medical care; the standards respected that the undergraduate medical education program is not the end stage in the continuous medical education process which the newly-graduates should go through within his whole professional life. On examining the basic principles and outcomes of the PBL that everybody agree about and supported by the available evidence, we can realize that PBL is doing well with the accreditation purpose and standards: PBL does prepare the graduates for the subsequent phase of their training; and even if PBL doesn't improve the knowledge content of the students, however it does improve the knowledge retention and application, PBL is built on strong, sound learning theories of constructive, self-directed, collaborative and contextual learning which positively affect the quality and outcomes of the learning process. Moreover, PBL promote life-long learning skills, critical thinking, problem solving and decision making skills and integrate basic and clinical science in a relevant learning experience, PBL students have better interpersonal, socio-cultural, and ethical competencies which satisfy the recent community needs which focus on attributes such as the requirement to improve physicians' communication and other behavioral skills, PBL does provide a more challenging, motivating and enjoyable approach to education, and finally, students work in a more humane, less-stressful learning environment toward which they show a high satisfaction.

However, we hope that the accrediting authorities and the quality assurance programs to play more active role in standardizing the educational processes and specifying the teaching strategies and the key performance indicators in medical schools that assure the high quality medical education and unify the educational outcomes of various schools. Examples of this specification or standardization may include how much self-directed learning is allowed, the number and purpose of the lectures and didactic sessions and those of the problem-based tutorials, how much integration of basic and clinical sciences is acceptable, what are the appropriate teaching methods in basic sciences education, and could all basic sciences be taught using the same strategy and instructional methods . This may also include the minimum required basic fundamental core knowledge all students should have in each discipline, and the intended learning outcomes and objectives in the cognitive, psychomotor and affective domains. At last, globalization of medicine necessitate the accrediting authorities in all countries to cooperate together in order to unite the worldwide medical education outcomes.

CONCLUSION

If we look at the curriculum as a living body, continuously evolving in response to our needs and based on strong evidence, if we imagine that this living body can sometimes get sick "with curriculosis, or curriculitis", this view may help us (who are concerned about the integrity of the medical education profession) create more practical and flexible system for overall curriculum management, follow up, evaluation, and review. This system would assist in constructing a curriculum liable for modification and continuous improvement in order to maximize the opportunities for efficient education and desirable learning outcomes. Continuously-evolving curriculum necessitates to recognize our own limitations, identify what we need to know more, consider students' needs and evaluations, take into account peer review, and external evaluation, broaden our sources of evidence as to learn from the experiences of other people around the world, listen to our feelings, pay attention to experts' opinions, our brain judgment, and the well-known rules and theories that proven successful in our field; all should be considered as sound sources of evidence that we need to count on to drive our decisions in medical education curricular development, not only the quantitative research, and mathematical numbers. We need to be open-minded, ready to accept constructive critique, flexible enough to admit the benefits of different approaches, believe that there is no single view of learning or teaching dominated what might be called "good teaching" and considered as the magic stick that will conquer all the faced challenges in medical education, instead it is a combination of various perspectives that constitute valuable response to the many pressures for change in medical education and have the potential to be good teaching; each approach can be a part of the solution along with other approaches. We need to have the courage to modify, incorporate, combine and blend the best of the PBL and conventional concepts in the educational strategies of the medical schools, seeking for the advantages of our students. What is needed is not to adopt one strategy in some courses and the opposite in the others, but the best of both approaches in one coherent and coordinated strategy. The best interest of the student is the aim that we need to work for, but we can only achieve it together by finding common ground and focusing on the future we look for rather than standing in the way of progress.

I conclude with an example for the continuous curricular evolving and development by incorporating other learning experiences in a classical PBL system: In Mac Master School in Canada, where the PBL approach was founded, two major curricular revisions and modifications were done since the inception of the original curriculum in 1969, , Under these modifications, concept-based system were introduced, emphasis is placed on underscoring the underlying concepts in the curriculum with a logical sequencing of both the concepts and the body systems. More didactic lectures were introduced to allow faculty to give introductory or wrap up overviews in areas where difficulties are anticipated for students facing such concepts for the first time. Strict body system curriculum became more porous, and recruiting tutors with content knowledge more helpful in feed-backing the students and in the guided discovery learning was encountered. Problems became shorter, more-focused rather than long, clinically-rich, multi-objective cases that may confuse the students and divert their focus to the clinical aspects at the expense of the fundamental mechanisms of the case. All these curricular changes were introduced to the previous PBL curriculum while the basic concepts of the original PBL philosophy of the founding fathers have remained constant. The emphasis remains on small-group tutorials and on PBL as the main focus of student learning in the curriculum despite the introduced menu of lectures and the faculty-led resource sessions [2].

Other suggestions for modifications in the PBL system, to enhance its yielded academic achievements,– may include the role of the tutor, the shared responsibility for learning between students and teachers, expanding the forms of the learning resources such as introducing more interactive lectures with a purpose to give the main structure, layout, glossary of terms and the basic concepts of various disciplines. A more important modification may include measures to sustain the integrity of the basic sciences' education such as constructing problems with appropriate designs to help preserve the fundamental principles of the basic sciences, guarantee that students acquire the core content of each basic science, and show the utility and relevance of basic sciences to medicine, and, besides, to think about additional suitable methods of teaching various basic sciences in the integrated PBL curriculum in order to maintain adequate education of such sciences and as a response to the claims that PBL philosophy may dilute the education of some basic sciences (example of anatomy that PBL does not work well compared to pharmacology or physiology that it does) [145, 146, 147, 148, 149]…etc. Finally, it is a challenge to all of us who work with either the PBL or the conventional approach to try to diminish any negative experiences in our teaching strategy rather than abandoning the entire system.

In the current stage, we need also a new perspective toward conducting research in medical education and more concern about the merit and integrity of the educational research seeking for more accountable evidence to support rational decision makings in regard to curricular interventions and development in our medical schools. Moreover, we need more cooperation and support from the medical schools' accrediting authorities and organizations which concerned with the quality of the medical education programs in standardizing the educational processes and teaching strategies which should be adopted in various medical schools in order to unify the global educational outcomes.

Lastly, As long as the costs do not overburden the medical school resources or the available countries' budgets, investing in a more positive medical education system for the benefits of the students, teachers, as well as the patients and the whole community, is a worthwhile goal. This goal should bring us together to play our role to support emphasizing such investment within our countries taking into our account that education and innovation will be the currency of the 21st century.

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Chapter 2

A MODEL FOR EFFECTIVE TEACHING FOR INTENDED LEARNING OUTCOMES IN SCIENCE AND TECHNOLOGY (METILOST)

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ABSTRACT

We have developed a Model of Formative Situation to Teach Science and Technology. It is intended as a basis for teachers' decisions to achieve quality in teaching; and also a theoretical ground to practically relevant educational research. It embodies a constructivist view where the fundamental constructs are: students' world, tasks, teacher mediation and intended learning outcomes. The model guided several studies, conducted by us and several collaborators, and was improved in a permanent dialog between the evidences found and our theoretical elaboration.

Further developments led us to develop a Model for Effective Teaching of Intended Learning Outcomes in Science and Technology. This model articulates the contributions of science and technology educational research in the last four decades. It incorporates the research studies made by the authors and fifteen years of field work. The model encapsulates diverse teaching approaches and educational goals. It provides a reading grid of science and technology educational research papers to help teachers in making choices according to specific students' characteristics and learning outcomes. The model also intends to aid teachers in identifying directions for their professional development and to point directions for science and technology educational research.

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1. INTRODUCTION

We have developed a Model of Formative Situation to Teach Science and Technology (MFS-TST). The main purposes of the MFS-TST are the following: (i) to provide the basis for teachers' decisions to achieve high quality in teaching (in the phases of planning, executing and evaluating their teaching); (ii) to be a theoretical perspective of Science and Technology (ST) education powerful enough to ground research that is relevant for the research community and for teachers' professional practice.

The MFS-TST considers: (i) how students' prior knowledge is taken into account; (ii) how tasks are performed by students; (iii) how the teacher supplies pertinent information and supports the intended learning outcomes; (iv) how students are involved in learning and how they use their prior knowledge and the information supplied; (v) how tasks are contextualized; (vi) how a specific conceptual field is mediated by the teacher.

In conceptual terms, the MFS-TST has two main aspects: the tasks given to students and the teacher mediation of students' learning. These two aspects and how they are articulated determine the competences, knowledge and attitudes that students may actually develop. This means that, if we know how a teacher teaches, then we can identify the characteristics of the learning that he/she is able to develop in his/her students and vice-versa (if we know what we intend as learning outcomes, then we can use the MFS-TST to determine what should be the main characteristics of our teaching).

Three practical tools were developed: (i) the conceptual field network; (ii) the PERT[1] diagram of formative situations; (iii) and the FS specification table. We also developed the concept "mediation in action" to clarify how to make mediation operational.

Further developments led us to develop a Model for Effective Teaching of Intended Learning Outcomes in Science and Technology (METILOST).

This model synthesizes and articulates the contributions of ST Educational Research (STER) in the last four decades with two broad contributions of the authors: fifteen years observing and describing classroom activities of students and teachers; twenty six research studies conducted in the last nine years.

METILOST encapsulates both student-centred and teacher-centred teaching; and it takes into account that each specific education system has specific goals.

It allows teachers to concentrate on two key-concepts (tasks and mediation), even though it contemplates subsidiary concepts (e.g., teacher effort, student learning effort, student world, learning outcomes, multidimensional assessment and autonomous students work).

METILOST provides a reading grid of STER papers to help teachers choose what may be more relevant for specific learning outcomes and students' characteristics; and it aids teachers in identifying directions for their professional development.

METILOST also points out some directions for future studies in STER.

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[1] PERT (Program or Project Evaluation and Review Technique) diagram, usually used in management, is a chart that synthesizes the crucial tasks and its sequence or interdependence to complete a given program/project.

2. THE PROBLEM OF EFFECTIVE TEACHING

In Science and Technology Education Research (STER) several suggestions have been made to make the knowledge generated by research more useful and relevant (Bennett, 2003): there are studies of synthesis (e.g. Tiberghien, Jossem & Barojas, 1997), of meta-analysis (e.g. Hammersley, 2002) and of pragmatisation of research (Evans, 2002)[2]. There are two interrelated gaps in ST education that need to be closed: first, what we teach and what students learn does not necessarily coincide (McDermott, 1991); second, research results have a reduced influence in classroom practices (e.g., Costa, Marques & Kempa, 2000; Gilbert, 2002). Consequently, many researchers elect as a priority to articulate research and teaching practices (e.g., Adúriz-Bravo, Duschl & Izquierdo-Aymerich, 2003; Buty, Tiberghien & Maréchal, 2004; Leach & Scott, 2003; UDC, 2003). Another way to face this problem is to capture the complex nature of ST teaching practices through teaching accounts (e.g., Alsop, Bencze & Pedretti, 2005).

Some engineers/researchers/teachers, influenced by STER, worried about effective teaching and learning in Engineering Schools (e.g., Ditcher, 2001; Felder et al. 2000) and already obtained significant improvements using active learning (e.g. Felder & Brent, 2003; Box et al. 2001), problem-based learning (e.g., Benjamin & Keenan, 2007) and curriculum developments (e.g., Moesby, 2005; Yeomans & Atrens, 2001), or teamwork (e.g., Aman et al. 2007; Felder & Brent, 2007), among other strategies.

Some conferences and journals such as SEFI (European Society for Engineering Education), ASEE (American Society for Engineering Education), CESAER (Conference of European Schools Advanced Engineering Education and Research), ICEE (International Conference of Engineering Education), IJEE (International Journal of Engineering Education), JEE (Journal of Engineering Education), GJEE (Global Journal of Engineering Education), whose main objective is to provide a higher quality in engineering education, are giving the necessary impulse and are taking into account the recent developments in STER. The topics most frequently found in engineering education literature are: assessment, learning outcomes, students' prior knowledge, peer review and assessment, teamwork, skills development, students' and professionals' performance, curriculum developments. These topics are not different from those found in other ST education journals.

However, research results still have a reduced influence in classroom practices (Costa, Marques & Kempa, 2000). Trying to approach this problem, a research movement tries to go into the classroom to study in what conditions a curriculum design is really implemented and how the development of students' competences, knowledge, and attitudes is improved (e.g., Anderson & Bach, 2005; Cravino, 2004; Koliopoulos & Ravanis, 2000; Marques et al. 2005; Martin & Solbes, 2001; Savinainen, Scott & Viiri, 2005). In some of the researches concerning learning or/and teaching, researchers propose partial models of what happens inside the classroom. For example, Scott, Asoko, and Driver (1991) propose a theoretical model of learning with relevance for the conceptual change based on earlier studies done since the 1970s (e.g., Viennot, 1979; Driver, Guesne & Tiberghien, 1985). In another example, Zimmermann (2000) proposes a model to describe and explain the development of

[2] Evans (2002) defines pragmatisation of research as "(…) *a planned process involving analysis, presentation and dissemination that is directed at transforming research findings into viable, specific ideas and recommendations for policy and practice*" (p. 202).

teachers. These models, in spite of their importance and relevance, are insufficient to help the teaching and learning of ST. Other researchers, trying to relate learning and teaching, propose a teaching method (e.g., Bot, Gossiaux, Rauch & Tabiou, 2005).

Some of this research tries to identify and organize the findings from the different research studies (Osborne, 1992; Tiberghien, Jossem & Barojas, 1997) in order to help the teachers. This kind of study helps to make a synthesis of the area, but lacks a theoretical view that would enable the researchers and teachers to relate all the ideas presented.

There are also studies that relate, in explicit ways, the personal experience of the authors with a particular view of STER or, more specifically, of physics education research (e.g., Laws, 1997; Mazur, 1997; Redish, 1994).

These types of studies may be more or less complete, but it is clear that they give crucial information to develop a theoretical model, which integrates the learning and teaching aspects in real classrooms. From these researches emerges the importance of tasks, mediation (argumentation, classroom talk, etc.), formative assessment and student world (culture, knowledge, affective dimension, etc.).

A model for effective teaching relevant to Science and Technology (ST) needs also to take into account the specific conceptual field[3] of ST to be learnt (Vergnaud, 1987, 1991; Lemeignan & Weil-Barais, 1993, 1994; Lopes et al., 1999). This implies identifying and making explicit: i) the relevant concepts and their operational aspects, such as relationships, operations and proprieties; ii) the theoretical models; iii) the relevant and appropriate contexts of use of the concepts (to a certain student level and characteristics); iv) the structure of the conceptual field. The much forgotten historical and social contexts of production of scientific concepts are obviously important, and must be also explicit.

This work approaches the problem presented above in a way that is relevant to teachers and researchers in teaching and learning ST at all levels: Basic and Secondary school and Higher Education.

2.1. Research Focus

This chapter focuses attention on three central components of ST Education and how they are interrelated: i) finding a teaching method with desired characteristics, based on research; ii) quality in teaching practices, including the learning experiences that are provided to students; iii) quality in learning outcomes. The relationship between i) and ii), and between ii) and iii) are of interest to teachers and STER. STER is concerned with the collection of evidence that allows to study the multiple aspects involved in those relationships.

In this chapter we present a Model of Formative Situation to Teach ST that resulted from successive uses in contexts of teaching and of research since 2000. It focuses the attention on central aspects of teaching Science and Technology (ST). It was published for the first time in 2004 (Lopes, 2004). Since then it has been successively used and refined in different contexts of research and education (primary and secondary school and higher education) in Portugal and Angola, resulting in 12 empirical studies, reported in 26 publications (Annex I).

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[3] According to Vergnaud (1987, 1991) a conceptual field is a set of interrelated concepts (emphasis on the relational nature of scientific concepts), with a certain dimension and structure, which allows subjects to operate, approach, think and act in a more or less wide class of situations and/or problems.

A formative situation is any formal scenario that is structured to provide to learners a certain experience in order to achieve a desirable set of learning outcomes.

This chapter proposes and explains a model that shows the fundamental entities and processes in the effective teaching of ST, to achieve the intended learning outcomes. So, we centre our attention in teaching practices, in the various school levels (from basic school to university) in ST and in the efficacy and efficiency factors of teaching according to the learning outcomes intended. In other words, we intend to evolve from a Model of Formative Situation to Teach ST (MFS-TST) to a Model for Effective Teaching for Intend Learning Outcomes in Science and Technology (METILOST).

The aims of this chapter are: i) to discern the permanent and the fundamental entities and processes in teaching of ST centred in teacher mediation of student learning besides the foam of the events related with their content and/or shape; ii) propose a model that allows to identify the efficacy and efficiency factors of teaching of ST according to the learning outcomes intended.

So, the model for effective teaching should allow:

(i) To understand what entities and processes are fundamental in ST teaching, in spite of the differences (in terms of aims, characteristics, practices, evaluation, context…) of the different educational systems and school levels;
(ii) To identify the fundamental ST teaching modes;
(iii) To understand what type of learning outcomes can be expected with each fundamental mode of formative situation;
(iv) To identify the efficacy and efficiency factors of each ST teaching mode.

We use the words *efficacy* and *efficiency* with their usual meanings. Efficiency is the quality of doing something well with no waste of resources. It deals with planning means, procedures and methods so as to get an optimization of available resources. Efficacy is the ability of something to produce the results that are wanted or intended. It is about producing a successful result, being successful in attaining aims and goals. In this work, we emphasize efficacy.

2.2. Departing Points: Generic Features, Constructivism and Intended Learning Outcomes

2.2.1. Generic features

This chapter and our whole work assume these basic guidelines:

(i) Each educational system has different contexts, curricula, aims and learning outcomes; and also different evaluation and assessment arrangements. One single official curriculum must be workable by dissimilar teachers. The praxis of a teacher is based on personal experience, knowledge, competencies, conceptions about teaching and learning, psycho-epistemological preferences, visions about ST, personal believes, world views.
(ii) As shown by classroom-based research:

There are critical features that must be taken into account: students' worlds, tasks, conceptual field, mediation, formative assessment and learning outcomes.

The time to learn is different from the time to teach: they do not occur simultaneously (e.g. Hiebert & Wearne, 1993; Drew, 2001).

Teaching and learning do not follow one single process. Their routes are different. They do not follow the same pathways, stages and sequences (e.g Lopes, Costa, Weil-Barais, & Dumas-Carré, 1999).

(iii) Constructivism is a fitting general theory. It embodies valuable didactical, social, psychological and epistemological contributions to education. We stress on two particular instances: conceptual evolution and social-constructivism.

2.2.2. Constructivism

The feature stated at item iii) above deserves some elucidations. There are several variants of constructivism and views about it (e.g. Bruner, 1961; Cobb, 1994; Gil-Pérez, et al., 2002; Salomon & Perkins, 1998; Taylor, 1998; Tobin & Tippins, 1993; Vygotsky, 1978). We present next a summary of the way we consider it.

Constructivism broadly states that knowledge is a human construct: it is not found or discovered; and it is not absolute, static and universal. This applies both to knowledge production by professional communities and to knowledge learning. The first world is much related to Epistemology and the second to Psychology. The later has also epistemological characteristics, because individual learning also deals with procedures of knowledge evaluation, context appreciation, criticism and validation. In this sense, it is adequate to talk about individual epistemology. It may be useful to remember that the well known "genetic epistemology" dealt precisely with the relationships between those two worlds: Piaget tried to understand the "genesis" of scientific knowledge by studying how it evolved in children.

Of course, the nature of the construct is not the same in both worlds. It is appropriate to say that a child constructs its own knowledge, but this does not mean that individuals re-invent by themselves what has been elaborated by coevals and ancestors. It means that the child, and no one else, must put together in a coherent building the pieces of knowledge that he/she can assimilate and accommodate with meaning making. No one else can do it, but adult guiding is crucial to it.

Both worlds have sociological components and characteristics. For instance, Science and Technology have a social nature: they rely on the legacy of preceding generations; they evolve in forums of professional communities; they look for answers to questions and solutions to problems that are socially marked in a multitude of ways; and they constitute a patrimony for future generations. Learning also has a social nature: from birth and all life along, individuals learn in permanent interaction with toys, books, parents, friends, and teachers; and they use natural language and other socially established languages to communicate and think. The designation social-constructivism is used to emphasize the role of social interactions, especially in the learning world (where it is easier to forget it).

Both in knowledge production and in learning, there are — in strong, multidimensional and multidirectional relationship: objects, events or phenomena that call for our attention; questions or problems; conceptual fields, models, theories and world visions; tasks to be made and methods and procedures to use; knowledge that is produced or learnt; answers to questions or solutions to problems of a certain degree of comprehensiveness, success, power and value; ethical issues related to that value; decisions to make and actions to undertake.

Constructivism is not stiff empiricism: it assumes that it is through our conceptual fields, models, theories and world visions that we see and study objects, events and phenomena. Constructivism is not stiff rationalism: it assumes that there are no conceptual fields, models, theories or world visions that are pure, not polluted by real world; it assumes that those constructs are elaborated in permanent dialog with physical reality. Constructivism refuses to give any separate meaning to pure empiricism or pure rationalism: it synthesizes the main contributions of those two philosophical trends.

Constructivism is related to evolution. It assumes that concepts and theories evolve in an unachievable spiral with sparse ruptures, both in knowledge production and in learning.

Constructivism is not relativism. Although it also assumes that concepts and theories have contexts of validity; and that contradictory intellectual constructs may coexist in a professional community or in an individual. This is well established in History and Philosophy of Sciences, Psychology and Education, since at least forty years ago.

2.2.3. Intended learning outcomes

As stated above on the summary of basic features, we must take account of students' worlds and learning outcomes.

We stress on this line of work: to depart from students' world and to state clearly the intended learning outcomes.

The intended learning outcomes are those which we consider adequate and which we look for. Included in their specification there are judgments, choices and implications for action.

The specification of intended learning outcomes is a teleological act. We are responsible for it.

Of course, we know that what is intended is not always achieved. We also know that when achievements differ from expectations we must reflect upon such disagreement. Namely, we should consider different intended outcomes or other resources, means and methods to attain them. We may also be led to reconsider the depart point, the students' worlds or, more rigorously, our view about them.

Here is a general formulation of our approach about routes connecting students' worlds and intended learning outcomes:

Teacher organizes situations and proposes problems and other tasks to students. A task mobilizes students´ worlds, conditions the desired activity and indicates appropriate resources. A task should motivate students. The accomplishment of a task by students allows to anchor the appropriation and the use of a specific conceptual field and to develop the intended attitudes, knowledge and competencies. Students should feel that they have learned.

Conceptual fields must take into account the students' world and contexts of validity and use. Working with conceptual fields is meant to enrich the conceptual fields of students, so they evolve into the intended conceptual outcomes.

The teacher mediation plays a central role. It is accomplished by proposing tasks, structuring teaching, interacting frequently with students and following-up their developments.

Specific teaching modes are preferable for specific intended learning outcomes. A combination of several types of teaching may be needed.

Intended learning outcomes deal with attitudes, knowledge and competencies. These may be of different types and levels. They may stress on practical, theoretical or ethical issues.

The main purpose of this chapter is to propose a model of effective teaching that points at intended learning outcomes.

2.3. Research Problem and Questions

This is our research problem: The need for a model to encapsulate the fundamental processes in any type of didactic models of teaching ST according to the intended learning outcomes.

If we address our attention to different formative situations such as sports training, airplane pilot training, fireman's training, laboratory technician's training, teaching ST in Angola, Portugal, England or in United States of America, parental education, citizen education, religious education, scientists' education, corporate training or formation of workers or managers, engineering production, scientific production, can we identify common aspects?

According to the mediocrity principle (Wagensberg, 2004 127-130), all formative situations have the same fundamental processes. The fundamental differences among them are the type of learning outcomes intended and contextual constraints. However, what is determinant to encapsulate the fundamental processes in a particular formative situation is the type of learning outcomes intended.

Can a model about teaching of ST explain the existence of the different didactic models of teaching ST, different types of teaching practices and do these induce different learning outcomes?

The results from STER never question the existence of somebody who explains, helps, challenges, encourages, gives information or support, and provides a "good" teaching sequence or a certain learning experience. This dimension of teaching is the mediation of student learning and requires an extra person or a community. What STER investigates is the nature, characteristics, conditions, emphasis, the role or the social demands of this mediation. The mediation is an invariant process to all types of didactic models of teaching ST and their teaching practices.

Also, the STER results never question the need for students to execute certain tasks. What STER investigates is the nature, the focus, the characteristics, the conditions appropriated, the role of the executing tasks, the components of effective tasks or the alignment between tasks and skills to develop, the interaction among students, tasks and teacher mediation, etc. Students performing tasks is an invariant process to all types of didactic models of teaching ST and their teaching practices.

The social relevance of STER is to construct knowledge to improve the efficacy and efficiency of teaching.

If we know what is fundamental in any type of didactic models of teaching ST and their teaching practices, we can concentrate the research effort in that. We think that we can know what is fundamental in ST teaching.

Consequently our research questions are:

RQ1: What are the fundamental and permanent processes and entities present in any formative situation?

RQ2: What type of learning outcomes can we expect with each fundamental teaching mode in a formative situation?

RQ3: What are the efficacy and efficiency factors of teaching ST according to set of given intended outcomes?

3. The Fundamental and Permanent Entities: Tasks and Mediation

What is fundamental and permanent in any formative situation? To illustrate our answer to this question, we propose four small stories, based on our experience or on experiences reported in the literature.

3.1. Four Different Stories, the Same Concern

Story 1: School in Angola

Somewhere in Angola … I enter a school (with a group of a local teachers, I am the only white person) and I am welcomed by the school director. We talk at the entry of the recreational space. The school is an arrangement of different prefabricated annexes with larges spaces for the students to move around and play. The prefabricated annexes have a dilapidated appearance (broken glass, walls with inscriptions, fissures in the walls, roofs with blocks missing). The director informs us that the school aspect is the result of the vandalism by external students of the school. The younger, the majority with ages between 12 and 15 years, are playing (they run around and talk with each other). Our group does not excite the attention of the students. Meanwhile I try to know what the didactic resources that they use are. There are no laboratories or equipment and the main resource is the textbook manual. This is a single book, with no mention of the authors' names, and edited by the Angolan state. There are some computers in a room, which were used by the students in computer skills courses given by a local company. Meanwhile we go to talk with the school teachers finding them dispersed because they do not have a designated space to be and/or work. The majority of the teachers are young and they have not, in general, graduated from the university. Many teachers attend higher education; other teachers have just finished high school. The majority of the physics teachers do not have higher education in the area. In general, the teachers earn less than a policeman. I come in a classroom. The students are in silence, they listen to the physics teacher. The classroom is small and 45 students (is a normal number) are arranged in three rows of tables with two seats each. The walls have some inscriptions and are painted in dark colours, the roof is dark and partially damaged (missing some blocks). The light comes from the lateral windows of one side of the classroom. The tables occupy about 2/3 of the classroom area. The following is written on the left side of the blackboard:

> **Discipline: Physics**
> **Class: 7th grade**
> **Theme: Force and mass**
> **Summary: Types of forces and their effects**
> **Objective: To identify the forces that exist between two or more bodies and understand their effects.**

When we enter, the teacher had finished the synthesis of the previous lesson reminding that the force is all the action that applied in a body causing velocity or deformation.

The teacher draws in a blackboard one tree with leafs and she represents one leaf to fall and she said: when one leaf falls, the leaf does not go up in space and fall to the ground. The teacher continues:

There is not a single force…there are different types of force. Today we have as sub-themes the types of force and their effects.

The teacher questions: What type of force interacts in the situation of the tree?

The teacher does not wait for the students' reply (the students remain in silence and apparently attentive) and she appeals to the drawing of the tree to explain that interaction can be at a distance when the leaf falls and is attracted by the Earth and the interaction can be of contact when it arrives to the ground.

The teacher goes on: now because we know what is the attractive force, we can know what are its effects…

The lesson continues in this style, the teacher continues to talk about the repulsive force and attractive force, and contact force and force at a distance.

Five minutes before the lesson finishes, the teacher questions the class:

What type of force exists when a mango falls to the ground?

A student replies that there is a contact force.

The teacher immediately says:

Before we get out, I want to remind you that there are contact forces and forces at a distance and attractive forces and repulsive forces. And then the teacher dictates a task for homework and she finishes the lesson formally saying a goodbye to the students.

The concern here is to provide conditions, with minimum budget, that allows a large number of students to learn science. The formative situation has a teacher doing mediation and students learning and doing small tasks, trying to understand the information given by the teacher.

Story 2: Parental education

Marta is an 8 years old girl and she attends the regular school at a small city and the local music conservatoire. Her parents transport Marta from home to school and from school to conservatoire. The school is about 15km from house. The conservatoire is nearby the school, about 10 minutes walking. One day the parents ask Marta if she would like to go alone from school to the conservatoire. Marta replies, yes. Marta's mother talks with the school's management and formalizes the permit for Marta to leave the school alone, because it is a school policy that parents should take full responsibility in these situations. Meanwhile Marta's mother talks with the teachers and with the school staff explaining that she wants to teach Marta to go alone from school to the conservatoire. Meanwhile at home Marta's parents talk with her about the experience, they convey confidence and at the same time they give instructions about how careful she needs to be when she walks in streets, crosses the pedestrian crossings and with other pedestrians. On the first day agreed for the experience, Marta was expectant and very confident. Marta knew the way from school to conservatoire from her parents' car. Marta's mother was going to the school. She arranged with Marta that she would go in the front and that the mother would go behind her, at a distance enough to keep visual contact. This distance was never broken and all the decisions concerning the choice of pathway, when and where to cross the pedestrian crossings were taken by Marta. The experience is discussed in family: Marta fells confident, but she was finding her mother to be very near. The next time, the mother took the same procedure: Marta should go first and the mother would follow her, but now from a bigger distance. Marta left the school and the mother waited for Marta to gain distance. Meanwhile the mother talks with the school caretaker telling her about the previous experience. When the mother looks she does not see Marta anymore and decides to go after her, but the mother does not want Marta to see her. This new experience is discussed in family and Marta is confident and willing to do the walk completely by herself. It had already happened, after all. This third time, Marta walks from school to the conservatoire completely alone. At the fourth time, Marta discovers a small variant for the pathway only accessible to pedestrians. Theses experiences are reported by Marta to the family, the family is very proud. Marta's parents announce that Marta is prepared to make the daily walk al by herself.

The context of this story is family education to autonomy. Centres our attention in how the parents create conditions for their daughter to do the 10 minute walk from school to conservatoire on her own.

The concern is to make sure that Marta learns how to go alone from school to conservatoire.

In this formative situation, the parents mediate Marta's learning (encouraging, giving information and advice and putting her in a situation that allows her to learn by herself in a safe way).

Marta learns and has a chance to do the task by herself, improving her self-confidence.

Story 3: Extract from page 78 and 103 of Wagensberg (2004)

"Si no existe algún tipo de selección, todos los objetos y todos los sucesos son igualmente probables. En tal caso no hay nada que comprender. La selección es un artefacto para romper equiprobabilidades. En general, al científico se le despierta el olfato cuando percibe que algo se aparta de la equiprobabilidad, cuando descubre que algo se repite en la naturaleza, cuando observa cosas comunes en objetos o fenómenos diferentes. Es entonces cuando anuncia una nueva comprensión científica. Ocurre cuando existen condiciones que cumplir, cuando, oculta o no, resulta que actúa algún tipo de restricción, cuando hay selección. Entonces nombramos esta situación con cierta solemnidad, decimos que existe ley, conocimiento, inteligibilidad. (p. 103)

Cuando un científico tiene una buena idea, se la pasa a alumnos y colegas. Unas ideas se perpetúan. Otras se extinguen. […] Otras ideas con la misma pretensión de comprender la realidad compiten con las de la misma especie. Pero su perseverancia se decide ahora por colisión continua con la evidencia y se perpetúan por las bibliotecas como un valor renunciable. (p. 78)”

The concern is to provide to other researchers the possibility to appropriate and use ideas to understand reality. The context is scientific production. It centres our attention in the formative potential of a researcher and his peers. This formative situation has some fundamental entities: the researcher that mediates his understanding, by trying to convince his colleagues and these, in turn, execute tasks to verify the power of these ideas presented or to propose new ideas.

Story 4: Airplane pilot training

“Flying on a clear day from Connecticut to Montreal, you take Victor 14 over the Gardner VOR, to Victor 229. What do you do at that point, with hardly a thought?

First, you turn to the new heading, about 159º. You check your watch to see how your flight plan timing has worked out. You switch the second VOR from Norwich to Keene, and twist the OBS to 159º TO. Noticing that you're going from an east-ish heading (011º) to a west-ish heading (339º), which means you need to change your VFR cruising altitude, say from 5500 to 6500 feet. So, you put the mixture full rich, throttle up, and get into a climb attitude. You don't need to contact anyone at this point, but once at altitude it might be good to do a cruise checklist in order to switch tanks and lean the mixture. Flying along the airway, you'll need to bracket in order to find a heading that will keep you on track.

In paragraph form, it seems to be a long list. However, most any pilot does these things easily, not from some checklist but by second nature, and altogether they only take a few seconds.” (Todd, 2007).

The concern is to provide conditions for a young pilot to execute in a precise order and in a short time a sequence of actions. The context is the flight training and how it is done. The formative situation has an instructor that mediates the best way for the learner to do and understand a complex task. The learners execute tasks and sequences of tasks and try to appropriate and understand the reasons of a certain procedure.

3.2. Tasks and Teacher Mediation Are Present in any Formative Situation

In each story we can find two permanent and fundamental entities at the centre of each formative situation:

(i) a task, or sequence of tasks, proposed by a teacher, instructor, master or parent, that should be accomplished by a learner;
(ii) a mediation action by the teacher, instructor, master or parent that interacts socially with learners in order to promote a certain intended learning.

From a formative situation to another the differences are:

(i) the characteristics of tasks and aims for each set of them;
(ii) the characteristics of the teacher mediation and the aims of them;
(iii) the modes in which the teacher mediation can be articulated with tasks.

Tasks and mediation are strongly linked to the topic to teach and to the learners' characteristics.

Apparently there are several aspects that can determine the characteristics a formative situation. However, the fundamental entities do not change, as we illustrate below:

The quality or even the personal characteristics of teachers can just determine the characteristics of the teacher mediation and the educational potential of the tasks that they can propose.

The resources can just determine the possibilities of an intended mediation.

The institutional constraints, organization and their aims can just determine the intended learning outcomes and the real conditions to the tasks and mediation that can take place.

The research in ST education can just:

(i) influence how the intended learning outcomes can be enriched or what new learning outcomes are desirable
(ii) illuminate what tasks can be designed and how should be presented and what and how the learners can learn with them.
(iii) identify what social environments can improve the teacher mediation, and what are the teacher main roles to improve the student learning outcomes.
(iv) clarify the efficacy and efficiency conditions that allows with certain articulation mode between tasks and mediation can produce certain learning outcomes or fixing certain intended learning outcomes what should be the articulation mode between tasks and mediation.

The teacher professional development can help the teachers just to find new tasks, new tasks presentation, new forms of mediation (that need new resources) and better alignments between tasks and mediation.

3.3. Task

A task is the work demanded from students, that they must perform to reach, within a certain time, an answer to a question or other kind of request. A task has educational interest because the research about learning (e.g. Vermunt & Verloop, 1999; Bot et al., 2005; Laws, 1997; Redish, 1994) shows the importance of activity for learning and it is through it that the students can direct their attention to what they must learn and do. So every task with educational interest must give to students an acceptable control over their activity.

A task can be formulated as a problem or as a request for an action. In any case the concept of problem is central (Gil-Perez et al., 1999) to understand the role of a task.

It is necessary to differentiate task and student activity. The first concept refers to what is requested to the student; the second is what the student actually does. In fact, depending on the teacher's mediation, the student's execution may be very different from the work requested by the task. So the students' experience of learning depends on their real activity in the classroom.

A task has four general educational goals relevant for ST education. The most obvious is providing a real student activity in the classroom. As we saw before, that is important for the students' learning process. Second goal: only through a sequence of carefully chosen tasks it is possible to induce the development of the intended students' competences. A competence is developed through action that mobilizes knowledge (Cabrera, Colbeck &Terenzini, 2001, Fox & West, 1983, Kirschener et al. 1997, Valverde-Albacete et al., 2003, Wright et al., 1998, Perrenoud, 2003). Third goal: through the students' activity, demanded by a task, the teacher can access what and how students know about a topic. This is a condition for the teacher to do an adequate mediation. Fourth goal: the tasks can be a reference for students to develop an autonomous work. With the tasks proposed, if they are relevant, the students may know what they must study. In spite of these tasks' general educational goals, there are obviously specific goals for each particular task. If we consider the different tasks regarding their educational function and characteristics we may classify them using the following dimensions:

- Learning demands (for example: follow and understand a discourse or an action; routine thoughts and actions; appropriate and develop basic scientific processes; explore new situations or ideas; develop epistemic work; conceive and accomplish a project to reach a product);
- Format (final product, work demanded, presentation…)
- Complexity (obstacle, conceptual difficulty, knowledge requirement…)
- Empiric referent (information given, context, with or without explicit conceptual model…)

If we consider the different tasks regarding their educational function and characteristics we may classify them into five types (see table 1): i) exemplar or routine tasks; ii) traditional ST tasks; iii) exploring tasks; iv) epistemic tasks; v) project tasks.

As it may be seen in table 1, we do not consider, *a priori*, one type of task to be better than another, in the sense that all of them may be necessary. However, the types of tasks are ordered by the level of competences demanded and, consequently, by the level of competences that is possible to develop in students.

The formulation of tasks must have the following characteristics:

- It must be clear what is the action requested and its goal and it must be adequate to the characteristics of the students (students' previous knowledge, skills, attitudes and competences);
- The situation must be clearly formulated (in academic or in realistic terms) or references given to search for the main characteristics of the situation;
- The necessary resources must be appropriate and available;
- The task must demand a work and/or reflection that helps scaffolding the development of student's knowledge, skills, attitudes and competences (Pea, 2004).

Each type of task may be executed in progressive levels of difficulty, abstraction, concepts involved or competences available or required. It can also be oriented so that students appropriate/construct a basic conceptual field, consolidate a conceptual field or enrich and/or extend a conceptual field.

Table 1. Different type of tasks in ST education and their main characteristics and goals

Type of task	Main characteristics	Main goal	Examples
Exemplar or routine tasks	Oriented to show how students must work with concepts, tools, and/or devices. Oriented to training algorithmic use of concepts or basic skills with tools or devices.	Introduce the students to a conceptual field. Training students in basic skills.	Paper and pencil exercises. Manipulate devices.
Traditional ST tasks	Oriented to working in problem solving, experimental work or work with conceptual models in basic ST. Require a considerable practical and/or intellectual effort to elaborate an answer.	Learn, enrich and/or innovate with the main and traditional ST processes. Help students to appropriate/ construct an extended and solid conceptual field.	Problem solving. Experimental work. Modelling work.
Exploring tasks	Oriented to exploring situations or contexts, identifying problems, the need for new concepts and so on.	Help students to contact with the main problems of a knowledge area. Prepare students to use ST knowledge in a flexible way.	Use or recognize the same concepts in different situations. Exploring a real situation.
Epistemic tasks	Oriented to working in elementary epistemic demands of ST work.	Learn to use the basic epistemic processes demanded in ST work.	Identify problems. Argument in a discussion. Find solutions in practical context.
Project tasks	Oriented to conceive and develop, with certain autonomy, a project. A project work requires identifying a problem, search for the pertinent information and resources, choose an approach, and find, test and develop a product addressed to a certain public.	Offer to students a part of open curriculum (choosing to study what they are interested in). Develop high level competences and attitudes, including autonomous work.	Project a lift for a building, showing the main dimensions and technical and operational characteristics.

3.4. Teacher Mediation

The research about teacher mediation of student learning in ST classroom (for short we will refer to this as simply teacher mediation) is related with other well-established knowledge like interaction (e.g. Mazur, 1997; Hoadley & Linn, 2000), question-based learning (e.g. Pedrosa et al., 2005), classroom talk and its several discourse forms (e.g. Leach & Scott, 2003; Mortimer & Scott, 2003; Scott, Mortimer & Aguiar, 2006), information flow (e.g., Lemke, 1990); argumentation (e.g. Erduran & Aleixandre-Jimenez, 2008); new conceptions of interactions within the classroom (e.g. Shepardson & Britsch, 2006); classroom climate (e.g. Valero, 2002); student work autonomy (e.g. Pea, 2004; Reiser, 2004), among others. However, the teacher mediation is a subject not well known because it is complex in nature and, also, because there are few research studies centred in the classroom (Lopes et al., 2008a, 2008b). Besides, there is no comprehensive theoretical framework about the teacher mediation in ST classes. There is some work, done by Engle and Conant (2002), which points towards some basic principles. In spite of its specificity (the study focus is biology and argumentation) their work provides some ground for the elaboration of an evaluation tool to monitor, in a global way, the quality of teacher mediation in the classroom. There is also research in teaching practices (e.g. Tiberghien & Buty, 2007) that can help us with insights to analyse the teacher mediation as teacher practice in classroom.

Nevertheless, we need further empirical evidence about teacher mediation in ST classes to support a comprehensive theoretical framework.

We define *tentatively* the teacher mediation as the teacher action and language (verbal and not verbal) as a systematic answer to the students' learning demand in their specific development pathways to the intended curriculum learning outcomes (namely in terms of students' knowledge, competences and attitudes).

It is a well known result that the students have specific learning development pathways to achieve the desired learning outcomes (e.g Lopes, Costa, Weil-Barais, & Dumas-Carré, 1999). So, through mediation, the teacher should try to know what are the students' prior knowledge, competences and worldview, and systematically check the students' learning demand in their learning process.

The teacher systematic effort to identify what his/her students know and check the students' learning demand in their learning process are the two core components of the teacher mediation. The teacher can not do this for each and every student for two main reasons: i) in a class, it is impossible to pay attention simultaneously and permanently to each student as an individual; ii) it is well known that learning, in spite of the need for an individual effort, is a social enterprise (e.g., Felder, Woods, Stice, & Rugarcia, 2000; Mazur, 1997; Felder and Brent, 2007; Mortimer & Scott, 2003). In consequence of this, the teaching practice shows that the teachers develop several ways to deal with the students as a group.

To improve teacher mediation we should consider the intended learning outcomes. For example, if high level learning outcomes are intended, the teacher should provide support for learners in complex tasks, "that enable students to deal with more complex content and skill demands than they could otherwise handle" (Reiser, 2004).

Another reason teacher mediation is a complex phenomenon is because the classroom is a system in which the teacher is a member (even if with authority and more qualified) and the teacher must take into account, at the same time, the cognitive, affective, relational and social-political dimensions of what happens in the classroom (e.g., Valero, 2002; Weil-Barais & Dumas-Carré, 1998).

Our definition of teacher mediation has six components: i) action, ii) language, iii) students' learning demand, iv) students' development pathways v) learning outcomes and vi) curriculum intentions.

Because of their complexity it is not possible to encapsulate all aspects that determine how a particular teacher mediation takes place in a real ST classroom, with real students. Hence, we consider teacher mediation as a whole that can be studied in several perspectives.

4. Case Studies: Tools and Results

In this section, we present the tools that we have developed in some of our earlier research, namely tools to plan teaching, tools to specify the teaching actions and tools to manage the teaching of ST. We also present a synthesis of the results obtained in these case studies.

4.1. Tools to Plan the Teaching of ST

4.1.1. "Conceptual Field Network" Tool

Usually, teaching chemistry, or other ST area, is based on a disciplinary logic approach, which follows a sequence of topics of chemistry. The theoretical models, concepts and their relationships can be chosen according to themes of interest to students (in this case, ecology based STS contexts) and to competences, knowledge and attitudes to develop in each formative situation (FS). So, the teacher did not follow a simple sequence of topics of chemistry. Therefore, in our empiric case studies ([5], [14], [17]) we developed a "conceptual field network" tool.

What are the main goals of "conceptual field network" tool? The "conceptual field network" is a tool that allows to support and to settle the discussion in order to identify and to inter-relate the key-concepts, the contexts of use of ST concepts and the theoretical models. In fact, the "conceptual field network" allows centring the discussion on: i) the main conceptual aspects; ii) the differentiation of the epistemological status of each conceptual entity, namely the distinction between concepts and theoretical models; iii) the social context of use of ST concepts. In this sense "conceptual field network" is the first step to prepare a curriculum: settle the main curriculum options. It is also the base for future decisions on curriculum management.

Our experience is that the use of this tool provides an expedite way to support a serious discussion for some time before settling it. We used the same tool with good results in Chemistry and in Physics teaching, in both university and secondary school. Our experience shows that this tool allows for people with different academic and professional backgrounds to discuss and participate in educational tasks and research. In the research, reported in [5] the discussion with this tool had the participation of one researcher in physics education, one researcher in chemistry and one chemistry teacher (see figure 1).

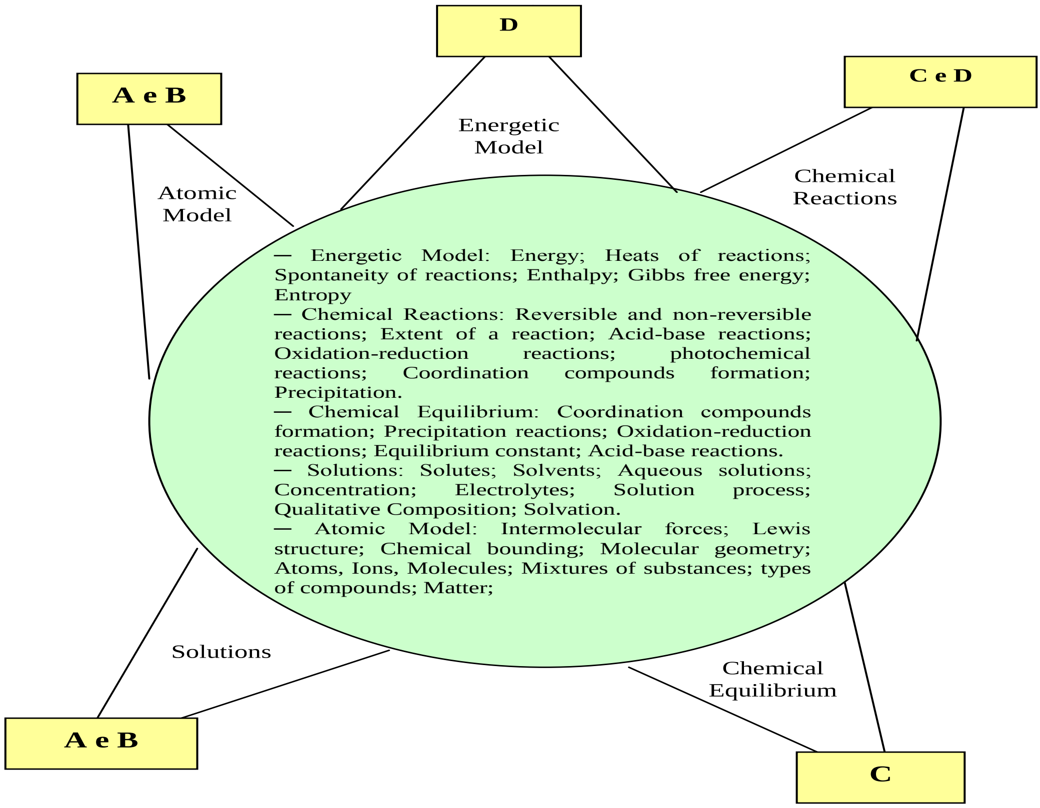


Figure 1. Example of a conceptual field network in university Chemistry. Legend: triangles indicate social contexts of use of concepts (A-Aquatic systems; B-Water environmental disasters; C-Pollution effects; D-Sustainable development); squares represent theoretical models; and ovals are used for key-concepts.

What are the main characteristics of the "conceptual field network" tool? A "conceptual field network" is a network those interrelates three entities: theoretical models, key-concepts and social contexts of use of the concepts. It may take several graphical configurations and change frequently during its elaboration. It allows analysing, epistemologically, the learning objects and making a draft of its distribution by formative situations.

Two examples of the "conceptual field network" are presented in figures 1 and 2.

How to construct the "conceptual field network" tool

A first step can be the choice of large contexts of use of the concepts. In the research reposted in [5], the main large context of use of chemistry concepts is environmental problems and the correspondent Science, Technology and Society (STS) relationships. The more specific contexts of use of chemistry concepts are (see Figure 1): A-Aquatic systems; B-Water environmental disasters; C-Pollution effects; D-Sustainable development. Each context of use of chemistry concepts is made operational by choosing specific situations.

The second step it is the identification of the main concepts of the course's syllabus.

The third and last step is a STS conceptual approach in order to identify and to put in relation the key-concepts of chemistry, their contexts of use and the theoretical models. In this way the "conceptual field network" supports and settles the discussion. For example, in study

[5] the atomic model became explicit as a necessary theoretical model to support conveniently the processes and concepts related with solutions. Another example is that, in study [5], the "conceptual field network" tool clarified that some contexts of use of chemistry concepts are more adequate to approach certain conceptual aspects than others. So, the use of the same concepts in several contexts allows an extension and generalization of the student's conceptual field.

In the process of curriculum design, the "conceptual field network" supports the teacher's decisions.

4.1.2. "PERT diagram of Formative Situations"

Another tool is a PERT diagram of formative situations that relates the different formative situations and chooses, as the development of learning, different sequences of formative situations. It was developed in the case study reported in [5].

The elaboration of a PERT diagram of formative situations has a correspondence with the contexts of use incorporated in the conceptual field network. In Figure 3 we present the main characteristics [contexts of use (C), theoretical models (M), key-concepts (KC), type of tasks (T)] of each formative situation and the relationships among them. The projects to develop by students were chosen by each group of students and carried out in several phases (plan, progress report, project completion, public presentation and individual critical report) throughout the semester, in and out of the classroom.

What are the main goals of the "PERT diagram of formative situations"? It is a tool to help the teacher in articulating all formative situations during the curriculum design and management. The designed "PERT diagram" may be modified during the specification of each formative situation. Also, it guides the teacher during the curriculum implementation and the curriculum development, because it may take different forms in the classroom, according to specific mediation and actual students' learning progress and interests. In particular, it is a guarantee that in each formative situation the students may work with concepts and models used previously, but in a new context.

What are the main characteristics of "PERT diagram of formative situations"? The relationship among formative situations is based on the connections among contexts of use of concepts, taking into account the key-concepts and theoretical models. In spite of there being an organization, there is no unique sequence. In particular, the development of project work in the project FS, as it really occurs, may pose different curriculum choices in different editions of the course. Another characteristic of the "PERT diagram of formative situations" is determining the type of competences to develop during the course, by choosing the types of tasks to propose to students in each formative situation. In the research reported in [5], one special cluster of competences are experimental competences, related to a part of the tasks proposed (see Figure 3).

How to use the "PERT diagram" tool? As a guide in the curriculum implementation and management, it helps the teacher to have a global view of the curriculum. In this way, it is a permanent scaffold to revisit theoretical models and some key-concepts in different contexts of use. It also helps the teacher in deciding the best path in the PERT diagram of formative situations according to the learning progress and interest of students.

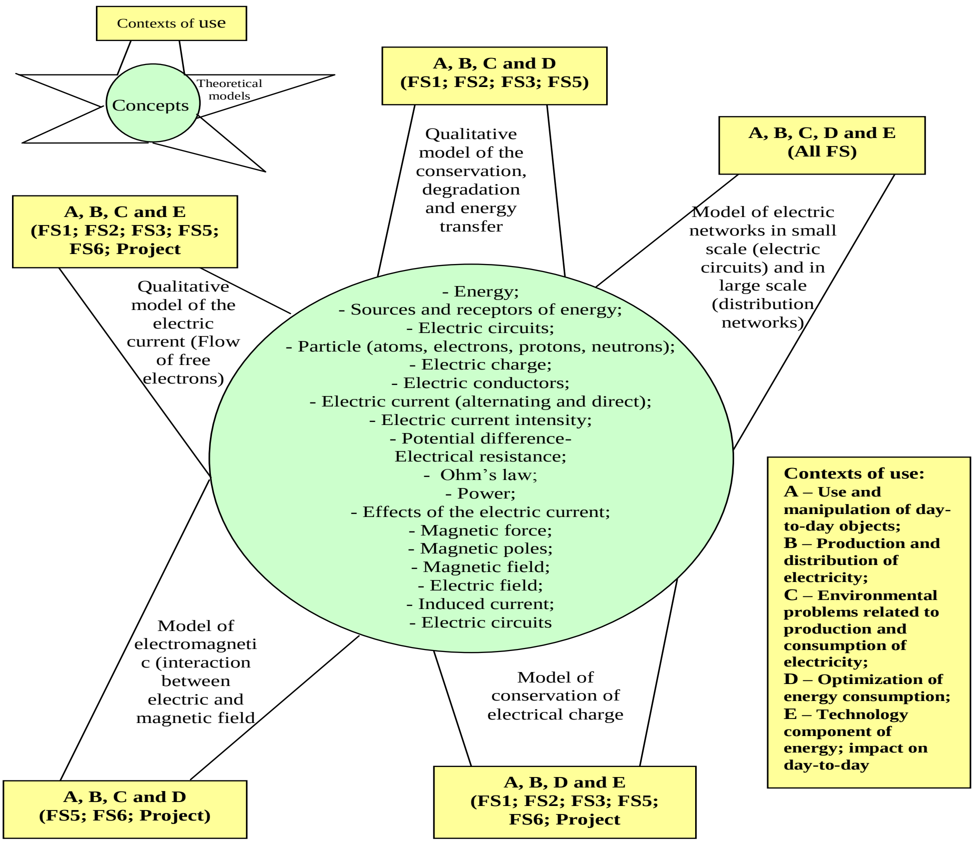


Figure 2. Excerpt of conceptual field network (example of teaching Physic in Basic level)

Table 22. Extract of a formative situation specification table (Physics in Basic level)

<table>
<tr><td colspan="5">Available knowledge: Basics about electric current and its daily use.</td></tr>
<tr><td colspan="5">Theoretical models: Qualitative model of conservation, degradation and propagation of energy, etc.
Central concepts: Energy; Source and receptor; Electric current, etc.
Proprieties/operations and invariant relations: In an electrical circuit, energy is transferred between systems; etc.
Contexts of use: Use and manipulation of objects of daily use.</td></tr>
<tr><td>Physical situation:
FS1: Lantern.
FS2: battery.</td><td>Problem:
How does the electrical current propagate?</td><td>Tasks:
T1: Sketch, figuratively, the inside of a flashlight and explain how it works.
(FS1; R1; M1, M2, M3, M6, M8) etc.</td><td>Resources:
R1: Flash-light
R2: battery, etc.</td><td>Traces of mediation:
M1: Confront the students with the physical situation; etc.</td></tr>
</table>

Knowledge: Develop the conceptual field of electrical current; etc

Competencies: Interpret, in energetic terms, the domestic consumption of energy, identify …; etc

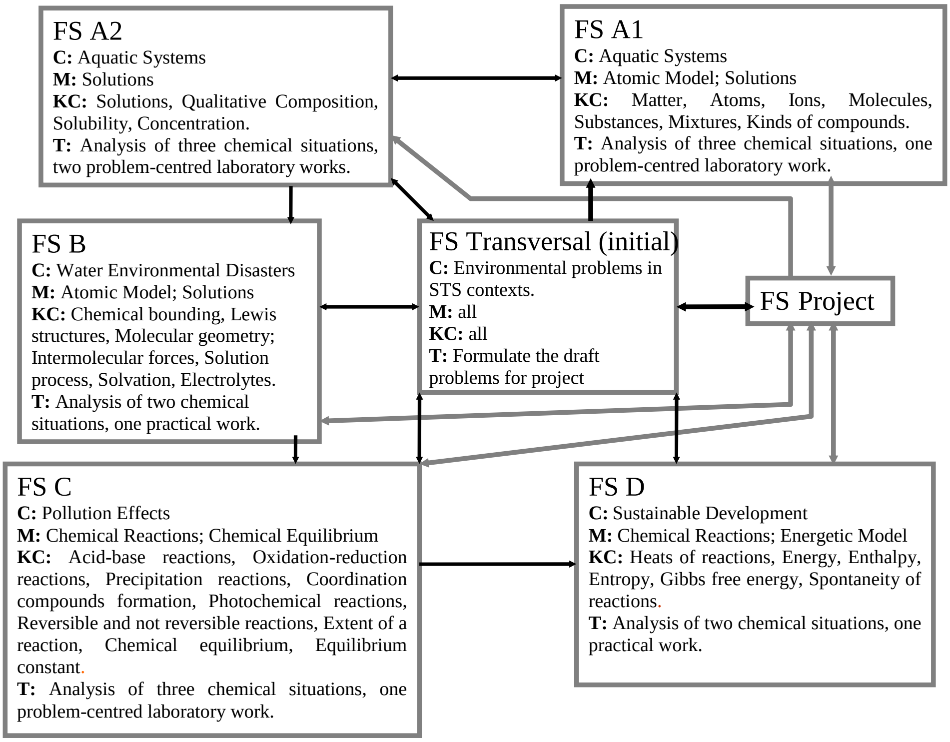


Figure 3. Example of a PERT diagram of Formative Situations (FS). Notes: C stands for social context of use of concepts, M for theoretical models, KC for key-concepts and T for types of tasks.

4.2. Tools to Specify the Teaching Actions

The next step in the planning of teaching ST is to specify the teacher actions and their sequence.

One of the tools that our team uses is the specification table (see tables 2 and 3), that allows identifying the entries to consider (available knowledge, models, concepts, properties and context of use), the outputs to consider (knowledge and competencies) and what needs to be done (connections among situations, problem, tasks, resources and teacher mediation).

One case, described in [3], uses the FS specification table (see table 3). With this case we intended to elucidate the role of "FS specification table" tool to plan the curriculum in an introductory Physics university course. Also other cases described in [14], [17] and [19] used the specification table.

As part of the curriculum planning, the teacher produced documents detailing the design and the specification of each formative situation. As an example of specification of a formative situation we present table 3 with a "FS specification table" for the formative situation called "The Sun and electromagnetic radiation".

The "FS specification table", as a tool, makes operational the crucial components of the curriculum and their articulation. In this sense, it is a permanent reference and support for the main teacher's decisions in managing the curriculum. It should be used in articulation with the previously described tools (the PERT diagram of FS and the conceptual field network).

Table 3. Example of a Formative situation—The Sun and electromagnetic radiation (Physics at university level)

Models: Layered model of the Sun; Model of nuclear fusion in the Sun; Models of electromagnetic (EM) radiation and photon beams. **Concepts:** Energy; energy transfer by conduction, convection, radiation; nuclear fusion; heat; temperature; thermal equilibrium; energy sources and receptors; system; energy conservation; particle (atom, proton, neutron, neutrino and photon); electromagnetic (EM) radiation; frequency, wavelength and wave propagation speed. **Relationships:** Rate of energy transfer by radiation: $R = \sigma\ e\ A\ T^4$; relationship between mass and energy ($E = m\ c^2$); energy of an EM wave; relationship between energy and frequency of a wave ($E = h\ f$); propagation speed of a EM wave; relationship among frequency, wavelength and propagation speed of a wave; equation for the calculation of power ($P = E / \Delta t$); $I = P / A$.				
Knowledge available from students: Concepts of particle, mass, heat, temperature, modes of energy transfer. Atomic model of matter and subatomic particles (electron, proton and neutron). Electric charge of electrons and protons. Notions about the importance of the Sun for life on earth and as a source of most energy forms used in the planet.				
Physical situation	Problem	Tasks	Resources	Teacher mediation
PS1: Data and schemes about the structure in layers of the Sun. [T1, T2]. PS2: Scheme of the EM spectrum and data about the various types of EM radiation [T3 to T7].	Starting from the effects of solar activity on earth and its human inhabitants, understand how the energy is produced in the sun, how it propagates in its interior and how it is emitted to space.	T1: Analyse the different layers of the Sun and the energy transfer processes that occur in these layers: radiation, convection and conduction. [PS1, M1, M4; R1, R2, R3, R9] T2: Analyse the chain of reactions (p-p chain) and perform calculations about the amount of energy produced in the Sun by nuclear fusion. [PS1, M1, M2, M3, M4; R1, R4, R9] A3: Characterise the different types of EM radiation, their uses and discuss the effects on human beings. [PS2, M1, M6; R6, R9] T4: Analyse the process of production, propagation and reception of a radio wave in terms of the associated electric and magnetic fields. [PS2, M1, M6; R7,	R1: Images of the Sun collected in the Internet and obtained form various observation instruments. R2: Data about the Sun. R3: Scheme of the structure of the Sun's layers. R4: Schematic representation of the reactions involved in the nuclear fusion in the Sun. R5: Scheme of the Sun with a digest of the processes that occur in it.. R6: Scheme of the EM spectrum. R7: Schematic representation of an EM wave. R8: Electronic equipment (TV or other device equipped with an IR remote control). R9: Overhead	M1: Presentation of information. M2: Make sure that each task is adequately appropriated and understood by the students. M3: Help students overcome their difficulties, for example, in solving problems involving numerical calculations or in data interpretation. M4: Evaluate the knowledge that students already have about the themes to be studied: the Sun, energy, heat and temperature, the concept of atom and its representations. Review these concepts and extend the knowledge about them. M5: Make synthesis and schemes of the fundamental information bout the Sun's structure and the production of energy by nuclear fusion in its nucleus [R3 e R4]. Summarize and systematize the fundamental information about the particles and EM radiation emitted by the Sun [R5]. M6: Evaluate the ideas that students already have on EM radiation, reformulate,

Table 3. (Continued)

		R9] T5: Discuss and characterize EM radiation as a wave or as a beam of particles (photons). [M1, M6; R7, R9] T6: Study the properties of infrared (IR) radiation with a TV and its IR remote control. [PS2, M2; R8] T7: Discuss experimental results based on registrations and observations performed by the students. [PS2, M3, M6; R9]	projector, blackboard and writing material.	extend and deepen these ideas by helping students analyse some of the less correct aspects under the light of adequate information and through critical analysis. M7: Give clues for the development of some of the ongoing students' projects, especially those related to EM radiation, and encourage the sharing of information that students may have already gathered in their research. M8. Summarize and systematize basic information about the characterization of the various types of EM radiation and the correspondent emission by the Sun [R5].

Knowledge to develop:

Understand the importance of the sun for the life on earth and for human activity. Deepen the concept of energy and knowledge of its transfer, transformation and conservation. Understand the relationship between mass and energy. Develop the concept of EM radiation, characterize the various types of EM radiation, their risks and uses. Develop the understanding of how models of the physical reality are built.

Skills and competences to develop:

Distinguish physical reality from its representations. Use models of the physical reality. Perform calculations with numerical data and critically assess the results, using estimates. Perform exploratory experiments and develop competences in the analysis of the correspondent results. Analyse data obtained from scientific instruments and understand how to interpret them. Understand the current limits of physical knowledge on various themes and use the available information to assess the plausibility of one or more possible explanations.

The "FS specification table" explicitly presents the main components of the curriculum: the student world, the competences, knowledge and attitudes to develop, the specific conceptual field, physical situations, tasks, resources and foreseen mediation. It indicates the main articulation among physical situation, tasks, resources and mediation (see table 3, in the respective columns, the crossed references indicated by the initials PS, T, R, and M). Also, the "FS specification table" gives a good idea of the temporal duration of the physical situations to approach and of the tasks to be executed.

During the FS specification table elaboration, the hardest work is the conception of tasks, foreseeing the mediation and articulating both. This instrument is important as a tool to prepare the curriculum, but is not a tool to follow in a rigid way during the curriculum implementation.

This tool allows to align the conceptual field (models, concepts, relationships) with student world (namely knowledge available from students), teaching effort (planning how articulate and sequence physical situation the problem, tasks to propose, resources available and traces of teacher mediation) and the intended learning outcomes (knowledge, competences and attitudes).

4.3. Tools to Manage the Teaching of ST

4.3.1. Case reported in [6-10]: Teaching introductory Physics course in an engineering school

The case is described in Viegas, Lopes, and Cravino (2007, 2009) [see also 6 - 10]. With this case we intended to show how the mediation can be made and how the teacher may change from one type of mediation to another.

This work, part of a curriculum re-design, based on STER, was developed in an introductory physics course in an engineering school of Northern Portugal. The goal was to improve students' competences using physics subject matter and its connections with daily life. The rational is that students will be better prepared to embrace their future profession – engineering – as they are able to recognize, identify, mobilize and interrelate their knowledge with the real problems they are bound to encounter.

Traditionally, in physics teaching, an appreciable time is spent solving exercises on the blackboard, an activity where students do little work. Viegas, Lopes, and Cravino (2009) presented an alternative approach, based on STER in general, and in the early version of a model of teaching in a formative situation in particular, to actively involve students and specially oriented to develop certain important competences in engineering students.

The authors were particularly concerned if this competence development approach would affect the final marks and if it would benefit the majority of the students. They were also interested in how students would percept this new approach and if they would feel comfortable with it.

First, a conceptual field network was developed, taking some contexts of use particularly interesting for engineering students (how an elevator works, car accidents and constructions). This network incorporates the interrelations between these contexts and the theoretical models and concepts present in the course contents (Newtonian mechanics).

The main concern is to put the teacher mediation in action as a tool to manage the teaching in and out classroom.

Basically, the authors used individual, collaborative and cooperative work in the tasks done by the students, in order to promote the development of competencies. The development of autonomous work and student's responsibility were also promoted.

Students were invited to develop a project ("How an elevator works") and in each lesson they developed a different task towards their final presentation. This project provided an integrating vision of the course and stimulated the collaborative work in class and after class. It would also imply some cooperative work, because students ought to be organized in order to deliver the final version of the project. No synchronism was imposed on the work of the different groups (proposed problems or project tasks); in fact each group worked at their own pace, achieving their own goals, developing autonomy and responsibility. Respect for fellow students and their ideas was promoted, in order to include everyone in the daily work.

The success of each individual student's learning achievements was assessed, on a weekly basis, with each student performing an e-learning task.

The teacher's role was to mediate these individual and group achievements, namely in discussing certain issues at crucial moments, encouraging students' performance and giving them permanent feedback on their developments, including in the homework tasks (individual weekly feedback). This took place mainly in the theoretical-practical (recitation) classes. When significant difficulties emerged, a personal consultation would be scheduled with the student for an office meeting with the teacher.

In the theoretical classes (lectures), the teacher used active learning engagement techniques, mainly cooperative work and peer instruction (Mazur, 1997), already tested in previous school years. The major concern was to establish class rhythm, in order to maximize students' attention. The teacher also introduced short self-tests, taken in class and immediate corrected in class by each student's neighbour, while the discussion of the solutions was being made. The students would not only verify the correctness of their answers, but also foresee different interpretations and be able to correct them. They could also gain sensibility to common mistakes they usually make, but to which they do not pay enough attention. Students were not graded based in the marks from these self-tests, only by the corrections they made and mostly by their participation in the process.

The e-learning challenges provided an opportunity for students to work together in complex problems, in which everyone could see each others answers, and could complete them or disagree with them. The teacher would supervise their interactivity and give clues whenever that was felt necessary.

The major modification in the laboratory classes was the almost total abolition of guided experiments. The authors opted for simpler laboratory devices to demonstrate simple concepts that were being developed in the theoretical classes. The final part of the semester was spent developing a laboratory project, intended to solve a specific problem, in which students, with laboratory material or other materials, should idealized, develop and implement an experiment that could provide the answer to that problem (Neumann & Welzel, 2007).

We found six mediation patterns:

Pattern A (about presentation of new information). This pattern is composed by the following phases: i) Teacher proposes a conceptual question to identify what and how students know about the topic; ii) students think about it and answer; iii) each student discusses with a peer; iv) Teacher discusses with class; v) Teacher presents information taking into account the previous phases; vi) teacher presents a new conceptual question to know the students' conceptual level of understanding.

Pattern B (about using knowledge by students). This pattern has the following characteristics: i) Teacher proposes a task to students; ii) students are organized in small groups and work autonomously in the task to find a solution (each team is not necessarily synchronized with the other teams); iii) Teacher gives support (identifying mistakes and alternative ways of developing ideas, identifying learning outcomes in order to fulfil any evidenced gap, and manages the curriculum, providing help, guidance and explanations in crucial moments, resisting the impulse of explaining everything, every time a student has a doubt, but instead giving clues, in order to let it be the students to reach out the solution); iv) Teacher supervises team discussions, stimulating everyone to participate, awarding grading points mostly for participation and not to punish students' mistakes; v) students give brief presentation of their work to teacher (not to all class) and discuss the pertinence of the solution they found, vi) The teacher visits each group several times in each class.

Pattern C (about Project work). This pattern is similar to pattern B. The differences are: i) The project is divided in several tasks and each one of them is developed in the beginning of the class, ii) the characteristic (v) of pattern B referred above only occurs in the middle and in the final of project work and the presentation is made to the entire class.

Pattern D (beyond class). This pattern is composed by the following characteristics: i) Weekly feedback on the e-learning homework, ii) the feedback is characterized by clues for completing it, alert students for major mistakes and stimulate further work; iii) teacher participation in the open discussions in the e-learning platform; iv) teacher suggests to some individual students office hours consultation; v) maintain a regular attendance in office hours.

Pattern E (about lab-work). This pattern is composed by the following characteristics: i) There is synchronism between the theme (chapter) being discussed in other classes and laboratory problems; ii) there is autonomous collaborative teamwork in solving the laboratory problems; iii) There is collaborative discussion with the teacher supervision; iv) Teacher gives weekly feedback on students reports and may suggest to each student an office consultation; v) There is a final laboratory project work (conceive and implement an experiment and obtain the experimental results) with the teacher supervision.

Pattern F (about assessment). This pattern is composed by the following characteristics: i) Teacher provides for regular self-assessment tests; ii) students' work (homework and in classroom) is corrected but mistakes are not graded; iii) Provide students with feedback on their learning outcomes; iv) Diversify assessment tools and give credit for the students participation; v) Evaluate how students prepare themselves to the tasks that they know they have to face.

The results obtained in this case clearly support that, in classes where the learning environment was based on the described mediation:

(i) The academic results were equal or even better than in classes taught in a more traditional approach;
(ii) High level competences were better developed in a larger number of students than in classes taught in a more traditional approach.

4.3.2. Case reported in [19-23]: Teaching optics in grade 8 (14-year-old students)

Global View of the Research. This research was performed by Branco (2005) [19-23] and the objective was to design, implement and evaluate a feasible research-based curriculum unit (optics, grade 8) that improves learning quality, teaching quality and students' satisfaction.

The design and implementation of this curriculum is based on an early version of a MFS-TST and takes into account the official curricular orientations (from the Education Ministry). The implementation lasted 7 weeks during the academic year 2002/2003.

This research was composed by three case studies. In the first, an action-research case study, the researcher implemented the curriculum design with a special focus on teacher mediation. In the second, an evaluative case study, another teacher (that has not participated in curriculum design) implemented the same curriculum design. In the third, an evaluative case study, a teacher implemented a curriculum based on available textbooks.

The optics curriculum was based on properties and applications of light. The contexts of use of concepts are: everyday situations, technological objects, experimental situations with everyday material and school models. The main theoretical models that are implicit in the use of concepts are: anatomical model of vision, light propagation (both geometric and wave models), interaction between light and matter, energy and information transfer. The "PERT diagram of formative situations" is composed by 13 formative situations, one of which is a project work developed by students (in groups), both in and out of the classroom. Each formative situation was specified in a formative situation specification table. In particular, all of the tasks proposed to students were previously tested, especially the experimental tasks. These experimental tasks were tested by the action-researcher and by the teacher in the second case study.

Teacher mediation in action in teaching management. First, the space organization was carefully considered: the tables were rearranged to allow for group work and the clusters of tables were disposed in a way to allow the teacher to work with all students. The resources were made available to all groups.

Second, since some classes demonstrated little interest in physics, the teacher structured the classroom climate by attributing specific roles to some students within the groups. There are three main roles: the student who leads group work; the student who reports the work of his group, the student who encourages his team to engage in work. Students in each group rotate in assuming these roles.

Third, the classroom discourse was organized in the followings three steps: i) faced with a task, the students are invited to execute it, mobilizing their knowledge and competences, and making explicit what they know about the subject (they write it on the board and on their notebooks under "What I know"); ii) after the execution of tasks, students are invited to make explicit "what I do", describing (by writing it in their notebooks) what they observed and/or done, to develop the answer to the first task; iii) after a discussion of student ideas and after the teacher's summary (based on students' work and ideas), the students are invited to make explicit "what I learn" (also by writing it in their notebooks).

Forth, the teacher decides, in general terms, the type of support to give to students' work and the type of information to give to students. The support given to students is meant to be a good equilibrium of tutoring, monitoring, negotiation and challenging. The tutoring is used when necessary, for short lapses of time. The monitoring is used during the students' execution of tasks. The negotiation is used after tasks execution. The challenging is used only in project work.

Below we present an example of a narration of a teacher-students dialog, before and after the task in the formative situation "How do we see what surrounds us?", that can illustrate the type of support given and the information flow.

"How do we see what surrounds us?". The students are invited to think and answer this central problem. After this task, the students register in the blackboard the main answers to "What I know": "*we see the objects that surrounds us by eyes* (the majority of students)*; we see the images through the vision, the light and the colour; we see because our eyes have a system to capture the image; we see because there is light and this light and our eyes allows us see*". After these answers the teacher proposes the following:

The teacher darkens the room and places an extinguished match in her hand. *Do you get to see what I have in the hand?* After the students' negative answer the teacher continues: "*But you continue to have eyes! Why do you not get to see the match?*". "*Because everything is dark*", the students answer. "*Then, in spite of you having eyes something else is necessary to see what I have in my hand. Is it enough to have eyes to see what surrounds us?"* The students answer then that, besides having eyes, light is necessary for us to be able to see the objects. The teacher turns on the light and repeats the experience, but this time with the match hidden in hand. "*Do you already get to see what I have in my hand? Why? We do not see because you have hidden the object in the hand!". "If I opened the hand would you get to see it? Why?". "Yes, because, in this condition, there is already light hitting the object!*" The teacher opens the hand and the students see the match. The students conclude that, in spite of keeping their eyes opened and the room being lit, this light must reach the objects for us to see them. Again the teacher darkens the room and asks a question: *"If I lit the match do you get to see it"?* After the students' positive answer the teacher lights the match and asks the students to complete task 1: To describe or to schematize (individually) the form how you see the match. The students show great difficulties in executing this task, but with some teacher monitoring, they manage to complete it. The spokesperson of each group tells everybody and then writes it in blackboard under "what I do".

After this, everybody engaged in a long discussion that ended with the students telling and writing "what I learnt".

4.4. A Synthesis about Tools and Results Obtained in the Case Studies

The results from the research studies that we have just presented, after the evaluation of the correspondent curriculum implementation, can be summarized in five results and one findings.

First result. School success (that is, the approval rates) improved. At the university level, where the students' participation in classes is not compulsory, we verified also an increase of students' attendance rates. At grade 8 level the students' enthusiasm and involvement is evident, especially in the classes where previous school success was very low.

Second result. The quality of learning was evaluated through validated tests of competences and interviews. Each test was validated and especially adapted to the conceptual field and learning level of each research. The results obtained show that the development of capacities and important competences in all the action-research cases is better than in the respective evaluation cases. In some cases the normalized gain (Hake, 1998) is twice larger. We note that the evaluated competences are a range of competences from low level (e.g. explain and describe phenomena) to high level (e. g. use knowledge in concrete situations and solve problems). We verify, also, the development of experimental competences in the chemistry research, where special attention was given to this kind of competences (understanding the problem to solve, technical competences, connection between the laboratory work and the theoretical concepts). In this case the competences were evaluated by direct observation (with the aid of an appropriate observation tool).

Third result. The quality of teaching in the university cases was evaluated through questionnaires based on an international standard (the CEQ - Ramsden, 1991). These show that the students have the perception that their teaching and learning experience was of high quality. In grade 8, the quality of teaching was evaluated through students' opinions (during and after the teaching) and also from students' participation in the "open week exhibition" (organized and setup by the students with the help of their teacher). For example a student says: "*In this period I liked the [subject] matter more. I found very interesting when we made the rainbow here in the classroom…, we learned a lot of things about our day-to-day* ". In the "open week exhibition" the students presented the experiences and tasks to their school colleagues. Some of these young colleagues say: "*it is a pretty exhibition [...] increases students' interest and they present more knowledge on the discipline*".

Fourth result. The curriculum management is very dependent from the teacher's experience, attitudes and knowledge, which have an impact in teaching organization and, above all, in teacher mediation. For example, in grade 8 research, the evaluative case with implementation of a curriculum design based on the early version of MFS-TST, was implemented by a teacher who had a poor background in physics and the research shows poorer results in some high level competences. In fact, the poor teacher background in physics reduced the quality of mediation. Another example is teacher mediation in the action-research case study in university chemistry. In fact, the systematic mediation based on a formative assessment, during the laboratory work, increased the students' experimental competences from a laboratory session to the next.

Fifth result. The early version of the MFS-TST was used to evaluate other curricula, even if grounded in other theoretical frameworks. In fact, the MFS-TST was also used to guide the interpretation of three evaluative case studies (research in university physics). It allowed us to focus our attention in the key-aspects of the curriculum, namely the teacher mediation and the evaluation of students' knowledge, and to understand the crucial aspects of each curriculum in the correspondent results in terms of students' learning and perceptions.

Finding. The different cases studies presented here show that the respective teaching scenarios are different, but in all of them are present, as fundamental entities, the tasks proposed to students and the teacher mediation, even if the processes in which tasks are articulated with teacher mediation change from case to case. The meta-interpretative study done by Lopes and colleagues (2008b) [26], analysing 35 studies, selected from 374 published in the years 2000 and 2001, in the three most important SER journals, also show that learning tasks and the teachers' mediation of these tasks play a key role in STER designed to influence teacher practice. In addition this meta-interpretative study shows that: «the studies that seek to develop students' knowledge present consistent relationships among ''tasks'' presented to the students, ''resources used'' in the completion of the tasks, ''mediation'' by the teacher, and ''learning environment"».

5. Overview and Purpose of a Model of Formative Situation to Teach Science and Technology (MFS-TST)

5.1. Relationship between Teaching and Learning

The Model of Formative Situation to Teach Science and Technology (MFS-TST) assumes, clearly, that teaching and learning are different activities and occur at different times: in general, the teaching happens before learning. The teaching can influence (and is expected to influence!) the learning of two ways: i) the more immediate learning, that occurs in the classroom almost simultaneously with the teaching; ii) the more independent learning, that occurs after teaching, which essentially depends on the effort of student. It is expected that teaching leads to autonomous learning in two ways: i) creating a need for autonomous learning; ii) as reference to what and how students must learn.

5.2. Some Basic Principles

Principle A - The teacher mediation plays the main role. A basic contribution of teaching is to mediate (to give support, among other aspects) the student learning in order to develop the students' conceptual field in a specific ST topic, approaching gradually the respective specific conceptual field of ST.

Principle B - The fundamental entities are tasks and teacher mediation. All didactic models of teaching ST centred in teacher mediation of student learning have the same fundamental entities and processes: tasks and teacher mediation. This principle can be supported by: i) the analysis of empiric data done in section 3; ii) the tools and results presented in section 4; iii) the analysis of empiric data done in section 5.8; and iv) can be theoretically justified using the mediocrity principle (Wagensberg, 2004: 127). So, a model of formative situation for teaching ST should encapsulate different didactic models of teaching ST centred in teacher mediation of student learning, different teaching practices, and these can induce different learning outcomes.

Principle C - It is not possible to deduce teaching models from learning theories. The research about how students learn ST is not sufficient to deduce a theoretical model about teaching because is not vast enough and because the existing learning theories are not mutually coherent. The successive attempts of doing that have been failing. So, in line with the complexity paradigm (Morin, 1990; Le Moigne, 1994), we propose a model about teaching of ST, centred in the teacher mediation of student learning, from which it is possible to study the learning induced in students. With a model of teaching it is possible to refine it, tentatively, in order to generate more effective didactic models of teaching ST.

5.3. MFS-TST

The early versions of the model are based on an implicit formulation by Astolfi, Darot, Vogel and Toussaint (1997), further developed by Lopes (2004). The model helps to design a ST curriculum, to plan the teaching and to manage it in the classroom. In general, a formative situation considers the teaching effort and the student learning effort/project. The teaching effort induces the student learning effort/project and has two poles: i) the tasks and problems to propose to students; ii) teacher mediation. The type of tasks, the type of mediation and the articulation between them determine the characteristics of teaching and the characteristics of the learning experience provided. These characteristics largely condition what knowledge, competences and attitudes can be developed in students. A multidimensional assessment of goals, approaches and learning outcomes is a process to regulate and improve teaching and learning (see figure 4).

The MFS-TST allows understanding that, according to what is taken into account, it is possible to obtain different teaching scenarios with different potentials. For example, a specific teaching may emphasize one or several of the following aspects: i) the knowledge already available from students; ii) real opportunities for students to perform tasks and formulate problems; iii) an environment in which the teacher mediation is of utter importance to provide relevant information and scaffold the intended learning; iv) allowing students to learn in a progressive and sustained way and provides the opportunities for them to use this knowledge; and or v) inducing student autonomous work.

Another central aspect is that the model considers the role of a task to promote a desirable students' activity. For example, with a task reported to a situation presented and explored, students are invited to develop a mental and practical activity, using their available knowledge, and having an adequate control over the activity. The students' actual activities are conditioned not only by the tasks proposed, but also by the teacher's mediation, by students' interest and involvement, and by the material and conceptual resources used. The student's learning experience (that is, student activity in the classroom), resulting from the student's accomplishment of the tasks, is the basis for the teacher's support in helping the student appropriate, reconstruct and use a specific conceptual field of ST. The student's activity and the teacher's mediation, obviously interrelated, act as scaffolding for the development of student's knowledge, competences and attitudes.

Consequently, in the model MFS-TST, the tasks and mediation are central. The tasks can mobilize the student world (the resources help and support this mobilization), taking into account a scientific, technological and social context relevant to the student world and adequate to a specific conceptual field to be learnt. In each context the specific conceptual field must be mobilized in a reasonable number of situations, because only in this way will the student's conceptual field gain unity.

In the model the starting point is the student world and student's knowledge, competences and attitudes to be developed; the arrival point is a set of learning outcomes. The ST contents are implicitly integrated in the teaching and learning through the characteristic of the proposed tasks and mediation. This point shows the importance of the analysis of the ST contents by the teacher in terms of a more or less specific conceptual field (the tool presented in section 4 may help).

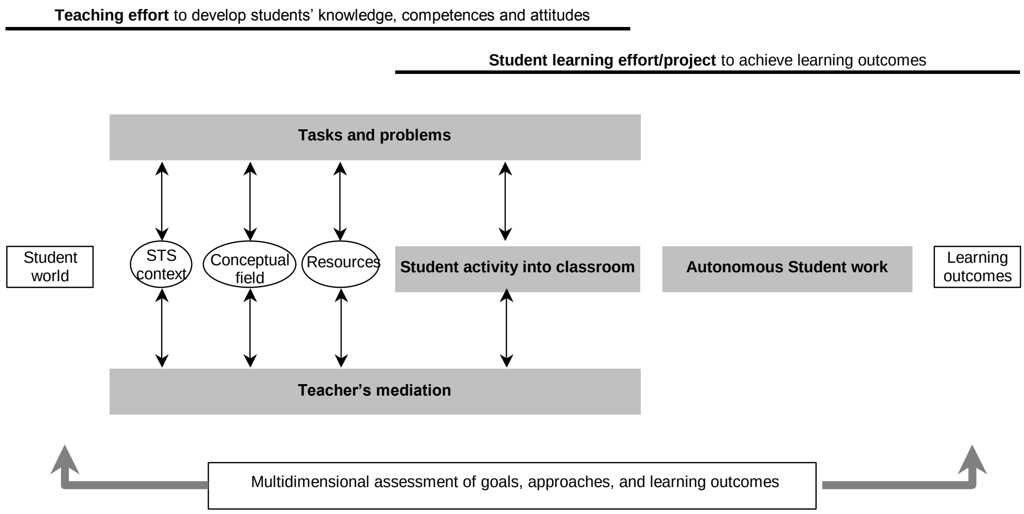


Figure 4. Model of a Formative Situation to Teach ST (MFS-TST) (adapted from Lopes, 2004:166).

The type of tasks, the type of mediation and the articulation between them (involving aspects such as situational context, conceptual field and resources used) determine the characteristics of teaching. These characteristics restrict, in large part, the knowledge, competencies (Lopes & Costa, 2007) and attitudes that can be developed in students. The multidimensional assessment of goals, approaches and results of learning regulate and improve the teaching and learning.

In theoretical terms the MFS-TST has a double foundation: philosophical and psycho-sociological.

The philosophical foundation clarifies that the epistemic subject is the student and the teacher is the mediator of the process of construction of knowledge by students. So, the teacher plays the vital role of organizing teaching, namely providing the learning experience to the students and supporting them. However, it is the student who learns. Thus, the student must have access to epistemic objects and work with them. The student activity and the situational contexts are crucial for the quality of learning. Formal education tends to organize the teachers' part and to shorten the duration of learning.

The psycho-sociological foundation clarifies that learning is a set of individual and social processes (Mortimer & Scott, 2003) that influence the human development of students and own teacher. In these processes, the language, conversation, engagement, confrontation, assessment, among other, are aspects of the teacher mediation that play a key role in learning.

The fundamental purposes of the model are: i) to provide the basis for teacher decisions leading to quality in education (in planning, management and assessment); ii) to put ST Education in perspective with the emerging research and practice questions that could be studied and the research results that may have relevance to professional practice.

5.4. Articulation between Tasks and Teacher Mediation

As we explained in section 3, the tasks and teacher mediation are central in our model of formative situation for teaching ST. How tasks are proposed, teacher mediation is accomplished and both are articulated (through mainly STS context, conceptual field and resources used) concern the teaching effort to develop the desirable students' knowledge, competencies and attitudes.

The student learning can occur during the teaching effort. However, the learning effort, most interesting and deepest, usually occurs after the teaching effort, when students develop autonomous work. How the teaching effort can influence the subsequent student work remains an interesting and central question relevant for research and practice. The time between the teaching effort and the achievement of the desired learning outcomes depends on the type of learning outcomes intended.

The articulation between tasks and teacher mediation involves essentially the contextual situation, the resources used, and the conceptual field and this articulation is regulated by assessment.

The contextual situation concerns putting in scene objects, events or information of scientific, technological or social nature that helps the students to understand the ST concepts and their contexts of use. The contextual situation must be used as a permanent anchor to learning and teaching and not as fleeting illustration (for example, Stinner, 1990). So, the contextual situation must be scientific, technologic and/or socially relevant, in the sense that it is relevant to the students and appropriate to the conceptual field of ST to be used. As a result the contextual situation helps to develop informed and educated citizens. We can relate this issue to science-technology-society (STS) research.

The resources needed to teaching and learning may be materials, laboratory equipments, school facilities, computers, tools, communication facilities or ST information, etc. The resources are an important way to assure that the intended activity demanded by tasks takes place. Space organization/configuration, even though it is not a resource *in strictus sensus*, assures the actual availability and usability of resources. Lemke (2005) presents an inclusive vision of the resources that are available to teaching.

The conceptual field (Vergnaud, 1987, 1991) is a set of interrelated concepts (emphasis on the relational nature of ST concepts), with a certain dimension and structure, which allows subjects to operate, approach, think and act in a more or less wide class of situation-problems. Besides, the construction/use of the concepts is carried out according to different interconnected dimensions: systems of representation (natural language, graphical, mathematical, etc.); mental schemas (concepts' proprieties, operations with concepts, relationships among concepts, theoretical models and models of situations); set of situations/problems in which the subject can mobilize and use the concepts with meaning. The subject mobilizes, at the same time, the representational systems, mental schemas and the repertory of actions, questions and meanings attributed by the subjects to a class of situation-problems that the subjects judge appropriate because they think that the target situation-problem is similar to others that they already know (Vergnaud, 1987, 1991). A conceptual field is therefore organized around a class of situation-problems. The more inclusive the class of situations/problems used in a conceptual field, the more structured and wide will be the respective conceptual field.

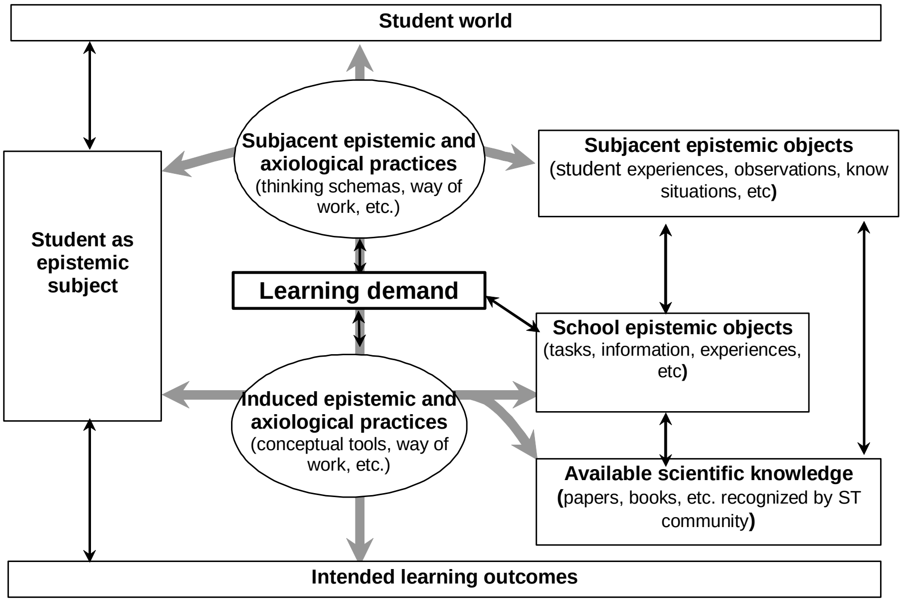


Figure 5. Epistemological reading of teacher mediation

The tool "conceptual field network" presented in section 4, encapsulates the conceptual field and contextual situations. It consists of a diagram representation with three entities: i) central concepts, ii) theoretical models; and iii) social context of use of concepts. This diagram is helpful to integrate in the model of formative situation to teach ST the contents, conceptual field object of teaching and its social relevance, and identifying the social context of use of concepts.

The assessment is a control process that can help students, teachers, parents and society at large to know in which way the student's world develops in the direction of desired knowledge, competences and attitudes. It must consider the work and effort of the student, the adequacy of the tasks, the pertinence of mediation and the quality of the mobilization of the ST conceptual field. Assessment must thus be multidimensional about goals, tools and approaches. Also, formative assessment is critical for the mediation process, namely to improve the quality of teaching and the enrichment of student's achievement. Etkina (2000), Bennett and Kennedy (2001) and Shepard (2002) have done research in this area.

5.5. A New Approach for Teacher Mediation

The philosophical translation of our definition of mediation (given in section 3.4) is represented figure 5.

The teacher mediation must intervene in two time perspectives:

1. From student world to the intended learning outcomes (the vertical axis in the figure). This is a perspective of teaching and learning in a timescale of hours/days/months. The respective epistemic and axiological practices should be planned. In this perspective it should articulate the learning demand of the tasks with

the epistemic and axiological practices provided and with the intended learning outcomes.

2. The interaction between the student as epistemic subject and the epistemic objects through the epistemic and axiological practices (the horizontal axis in the figure). It is a perspective of teaching and learning in a timescale of seconds or minutes.

The philosophic translation of teacher mediation helps us identify that its quality is determined by: i) how the tasks are actually performed by students, that is, what is the actual students' activity; ii) how the teacher provides relevant information (in terms of presentation, use and processing (Tiberghien & Buty, 2007)); iii) how the teacher scaffolds the intended learning, and creates the classroom environment considering how the classroom is socially organized, namely how the teacher power is exerted (Valero, 2002); iv) how students are involved in their learning (namely how they use their knowledge and information); v) how a specific conceptual field of ST is worked; vi) which resources and facilities are available for students; vii) languages (natural, mathematical, graphical, computational) used by the teacher and by the students.

The knowledge accumulated in STER and the experience of the authors of this chapter in several ST teaching levels, allow us to propose, tentatively, a framework of teacher mediation grounded in two theoretical perspectives: philosophical (namely in epistemic and axiological terms), and psycho-sociological. Each theoretical perspective can be made operational with five dimensions. The ten dimensions are a way of make operational certain aspects of teacher mediation. So they should not be seen in an isolated way. Our ten teacher mediation dimensions cover the didactical space of teacher intervention, but the interpretation of that didactical space can be different from teacher to teacher. Below we explain briefly each teacher mediation dimension within the respective theoretical perspective.

A. Philosophical perspective

A1 The work really demanded from students: A task is the work demanded from students, that they must perform to reach, within a certain time, an answer to a question or other kind of request. Our focus is the work really demanded from students and not the task as previously planned by the teacher. In fact, depending on the circumstances of a particular class, the work really demanded to students may be quite different from the task previously conceived or proposed by the teacher. The educational interest of a task is well established in the research about learning (Vermunt & Verloop, 1999; Bot et al., 2005; Laws, 1997; Redish, 1994), since it shows the importance of activity for learning and that it is through it that the students can direct their attention to what they must learn and do.

A2 Scientific and technological contexts: This concerns how the contexts and physical situations are taken into account, namely if problem solving is based in realistic contexts and if tasks are authentic (Hill & Smith, 2005). We consider aspects like: the types of situations that are used to work with concepts, laws and principles; how the situations are modelled and exploited.

A3 Epistemic and or axiological practices: This concerns the student work in certain type of practices to construct ST knowledge having as reference the ST practices in the context of ST production. This characterization uses epistemological foundations that arise from the analysis of scientific production in enlarged context (Kelly & Crawford, 1997; Kelly & Chen, 1999; Kelly, Brown, & Crawford, 2000; Reveles, Cordova, & Kelly, 2004). We should look for aspects like: i) Description (The teacher asks and aids students to describe phenomena); ii) Phenomena in context (The teacher asks and aids students to recognize phenomena in context); iii) Phenomena-representation (The teacher asks and aids students to connect physical phenomena with representation); iv) Representation-physics construct (The teacher asks and aids students to connect representation with ST constructs); v) Translation (The teacher asks and aids students to translate from observational to conceptual language); vi) Prediction (The teacher asks and aids students to predict what happens based on conceptual knowledge).

A4 Information: How the information is presented, used and processed. We should look for aspects like: i) what information, ii) the source of information, iii) temporal patterns of the information presention iv) pattern of information use and processing. (Tiberghien & Buty, 2007, Lemke,1990).

A5 Teacher awareness and real-time decision-making in the classroom. This concerns teacher awareness about students' learning pathway, in epistemic terms, taking into account the intended learning outcomes. So, the teacher may take real-time decisions about how to help students, for example scaffolding students' work to confirm or infirm their ideas, procedures or practices.

B. Psycho-sociological perspective

B1 Classroom talk: How classroom talk is considered. Leach and Scott (2003) propose two dimensions to analyse the classroom talk (authoritative/dialogic and interactive/non-interactive). We should look for aspects like: i) communicative approach; ii) patterns of interaction. (Scott, Mortimer & Aguiar, 2006).

B2 Support and authority given to students: How the student's work occurs in the classroom. The student work depends on the type of support given by the teacher and the authority awarded to students (Engle & Conant, 2002). In particular the teacher may directly guide the students or structure and problematize their work (Reiser, 2004). We consider aspects like: i) type of support given; ii) class work organization; iii) students' role in performing and/or problematizing tasks; iv) pattern of student work in terms of time, resources used and autonomy given by teacher; v) authority given to students. Mediation can become more effective, for most of the students, if the teacher is able to empathize with them, providing an active social environment (Felder at al., 2000), where students feel comfortable discussing and presenting their ideas with each other (Redish, 2003).

B3 Productive disciplinary engagement (Engle & Conant, 2002). Look for student engagement of disciplinary topics (and learning outcomes achieved) and how teacher can improve that.

B4 Assessment and feedback: Whatever the kind of task performed (assignments, classroom questions, self-evaluation tests, etc), it is very important that students get proper and timely feedback on their learning outcomes. This feedback works both ways (Viegas, Lopes & Cravino, 2009): teachers get relevant information about their students' learning evolution and students get useful (and timely) information about their own personal achievements. Another important aspect of teacher mediation is the quality of assessment. The assessment of learning outcomes, performed on a regular basis, must provide relevant results concerning the learning outcomes on both the competences developed and the concepts learnt. (Felder, Woods, Stice, & Rugarcia, A., 2000).

B5 Learning induced: In terms of how students' learning can be extended outside the classroom.

Some of these perspectives help us to understand better what are the relationships among the teacher action and language, the student learning demand and students' development pathway

5.6. How Can We Use the Model of Formative Situation to Teach ST (MFS-TST)?

How can the MFS-TST be put to practical use?

The MSF-TST provides a theoretical tool to help the preparation of the curriculum and the management of the curriculum in the classroom. It also allows the identification of the main characteristics of teaching practices. We will now analyse each of these potential uses.

5.6.1. MFS-TST and the preparation of the curriculum

Concerning the preparation of the classroom curriculum, the MFS-TST allows the central aspects of learning and teaching of ST in formal contexts to become operational (see Figure 6).

First, the MFS-TST helps to identify in the normative curricular documents the key-aspects like ST contents, competences to develop and the scientific, technological and social relevance of the ST contents. Then, it also helps to identify a conceptual field network with three key-aspects: theoretical models, key-concepts and relevant contexts of use of the concepts. From this conceptual field network it is possible to make explicit, from the point of view of the expert, the main aspects of each specific conceptual field associated to each curricular unit to teach: key-concepts, models (theoretical and from situations), operations with concepts and models, language used, contexts to use concepts and models, historical and social contexts of production of concepts.

Second, the MFS-TST helps to choose the situations that allow for the contextual use of concepts by the students. The teaching and learning must be centred on tasks, strongly related to a contextual situation-problem and to a conceptual field, in order to mobilize the student world and permanently improve learning. The teacher needs to articulate the characteristics of a specific conceptual field with the competences to be developed and the identified student world with tasks and the contextual uses of the concepts. So, the contextual situation must be carefully chosen by the teacher, taking into account the students' interest, since it will condition the tasks, the development of competences and the usability of a conceptual field.

Third, after this work, it is possible to create clusters of relevant contexts, problems, tasks, traits of mediation and specific conceptual field to be used. So, the first draft of the curriculum plan is a PERT diagram of formative situations (only with some key-aspects identified like competences, situations, tasks, models, contextual use). Actually, the curriculum design itself is a network of formative situations. Each formative situation is adequately designed if most aspects can be anticipated with precision. When all formative situations are drafted, they must also be articulated in a network, not as a simple sequence. It is important to anticipate the possibility that the order and emphasis of formative situations may be altered, if the students' needs or other constraints require that. This is why a PERT diagram articulation of formative situations is better that a simple sequence.

Fourth, the specification of each formative situation through the central aspects of FS (see Figure 4) may become operational using a specification table similar to those shown in tables 2, 3 and 4. The student world cannot be completely anticipated. But some aspects are possible to anticipate: use of certain types of objects, the knowledge of certain aspects of situations, certain conceptual demands. The other aspects related to the student world can only be known during teaching. Making explicit the conceptual field of a specific topic involves identifying the key-concepts, models (theoretical and from situations), operations with concepts and models, language used, contexts of use of concepts and models, historical and social contexts of production of concepts. This work allows the teacher to choose and clarify the contextual situation and, above all, articulate, in a flexible way, the tasks with mediation within each formative situation. It also allows articulating the different formative situations. The first approach to a situation is to formulate problems based on it. The necessary resources for solving it must be available. The characteristics of the tasks to propose from students must allow: i) to mobilize the students' available knowledge; ii) approach the chosen concepts, and iii) develop the intended competences. As we have seen before, the teacher mediation can reduce or improve the educational potential of tasks. So, the teacher mediation, even though it cannot be entirely foreseen, must be carefully prepared to guarantee certain desired traits of teaching and learning. In table 4 the vertical double arrow indicates the need for temporal articulation and the horizontal arrow indicates the need for articulation among situation-problem, problems, tasks, resources and mediation.

If a teacher prepares an enriched teaching, he/she must expect some complexity in the classroom environments. This complexity may be manifested by: i) the self-regulation (influence on contexts choice, self-assessment); ii) the multiplicity of learning paths in the same educational space (manifested by the characteristics of student activity and the correspondent mediation and by the network organization of formative situations); iii) the mobilization of the student world to improve the knowledge, competences and attitudes to be developed.

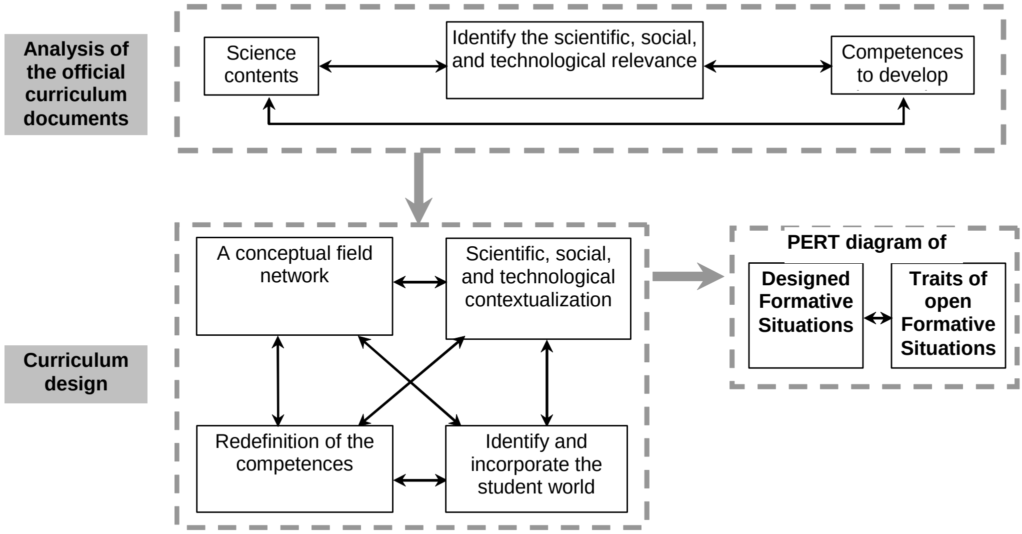


Figure 6. Operations to prepare a teaching using MFS-TST (adapted from Lopes, 2004)

Table 4. Formative situation specification table

Student world (conceptions, available knowledge, life experience, interests…)				
A specific conceptual field (key-concepts, models (theoretical and from situations), operations with concepts and models, language used, contexts to use concepts and models, historical and social contexts of production of concepts)				
Context (STS)	Problems	Tasks	Resources	Traits of teacher's mediation (Which information and when? Which scaffold and when? Which questions and when? Which synthesis and when? Which dialogue and when? Which teacher ST and when?)

Students' competences, knowledge and attitudes to be developed and learning outcomes
Note. Adapted from Lopes (2004).

5.6.2. MFS-TST to manage and to analyse the teaching of ST in the classroom

The main goal of the curriculum management in the classroom is to improve the students' knowledge, competences and attitudes, achieving the desired learning outcomes (see figure 7). Obviously, the first tool to manage the curriculum is the curriculum design itself. The other tool is the MFS-TST that guides, theoretically, the use of conceptual field network, contexts of use of concepts, and above all guides the articulation between tasks and mediation that induce student learning activity. The most sensitive aspect of teaching management is the teacher's mediation, because it takes a particular form with each specific teacher and students, in their particular circumstances, and it may change, even inadvertently, from one type to another, in general degrading its educational potential.

The tasks mobilize the student world, condition the desired student activity and indicate what the appropriate resources are. The accomplishment of tasks by the students allows to anchor the appropriation and use of a specific conceptual field and to develop the intended competencies, knowledge and attitudes.

The teacher mediation of students' work helps to choose the appropriate tasks and verify if each task is clear to the students and if they correctly appropriate it. It also allows identifying the characteristics of the student world, to incorporate assessment to adjust the teacher mediation itself and to verify if the competencies, knowledge and attitudes are being developed. Through the mediation, the teacher helps the students mobilize, appropriate, reconstruct and/or use a specific conceptual field. The articulation among tasks and teacher mediation performed by the teacher determines the learning experience provided and induced to students. The quality of this articulation is influenced by the quality of teacher preparation and both influence the students' learning effort. The ensemble of "teaching preparation", "learning experience provided and induced" and "student learning effort" determines the quality of students' learning outcomes relatively to the initial student world (see figure 7).

The MFS-TST allows the teacher to take into account the complexity of the classroom climate, without losing the necessary control about what happens inside the classroom.

Finally the MFS-TST may be used to analyse the curriculum management in the classroom (independently of the curriculum design nature) and identify its strengths and weaknesses.

5.7. Potential, Limitations and Conditions of MFS-TST

The MFS-TST may be used in formal learning contexts (e.g. ST education, classrooms at several educational levels and institutional constraints), in informal learning contexts (e.g. ST museums, educational centres, entertainment centres) and in professional learning contexts (e.g. professional work contexts, professional development). The focus is the student (or apprentice or professional) learning and what the teacher (or instructor or supervisor) must do, in certain conditions, to promote lasting learning.

Another important potential use of the MFS-TST is to guide future researches in ST education, especially if they are directed to questions of practical relevance.

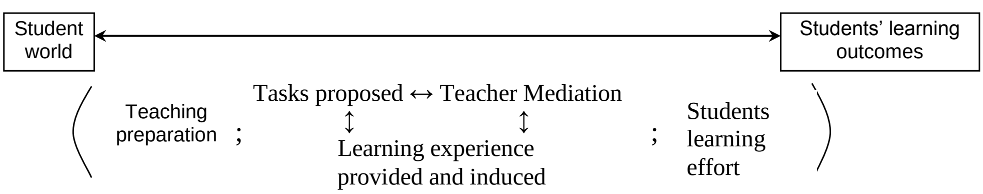


Figure 7. Components and process of curriculum management in the classroom based on the MFS-TST (adapted from Lopes, 2004).

The MFS-TST has, obviously, some limitations. It is a theoretical tool that assumes that teaching must be directed to learning outcomes and these may take different forms and levels. Also, the MFS-TST may be further developed and become even more operational.

5.8. Studies Conducted in Portugal and Angola that Used the MFS-TST: Overview and Results

In this section, we report on 12 empiric studies (see table 5) that used the MFS-TST: 11 case studies (completed or in progress) conducted in Portugal and Angola, and one meta-interpretative study. In all case studies, the quality of teaching was evaluated by questionnaires based on an international standard (the CEQ - Ramsden, 1991) and teachers' interviews, and the quality of learning was evaluated by conceptual tests and competencies tests, comparing normalized gains.

Furthermore, in some studies, the teaching practices were also characterized. The results of theses studies were successively published and presented at international meetings, in a total of 26 publications ([1] to [26], see annex I)

Table 5. Empirical studies that used the MFS-TST

Study (author) [and context]	Nº of teacher that used MFS-TST	Nº of classes involved	Context / Level of education	Publications listed in annex I
Teaching of introductory Physics Courses in Portuguese Public Universities (José Paulo Cravino) [Completed PhD]	1	1	Education/ Higher Education	[1] to [3]
Teaching Physics in Civil Engineering degree programs and the new paradigm of European Higher Education: curricular proposal for Introductory Physics courses in Civil Engineering. (Vitor Amaral) [Completed MSc.]	1	1	Education/ Higher Education	[4]
Contributions to Promote the Quality of Learning in General Chemistry in Higher Education (Cristina Marques) [PhD in final stage]	1	1	Education/ Higher Education	[5]
Identify and Test Efficacy Factors to Improved Teaching Practices in Physics courses for Engineering Undergraduates in Higher Education (Clara Viegas) [PhD in final stage]	3	7	Education/ Higher Education	[6] to [10]
Teachers' education through their Practices – contributes to promote Scientific Literacy among the Portuguese (Alexandre Pinto) [PhD in progress]	1	1	Formation/ Higher Education	[11]
Development of mediation strategies to increase the self-efficacy for teaching Physical Sciences in the initial training of Basic Education Teachers (Rolando Soares) [PhD in progress]	1	1	Formation/ Higher Education	[12]

Table 6. (Continued)

Construction of reference practices in Physical Sciences Education in Secondary School (Ana Edite) [PhD in progress]	3	3	Education/ Secondary	[13]
Development of curricula focused on formative situations – the role of graphic language in learning (Elisa Saraiva) [Completed MSc]	3	3	Education/ Primary	[14] to [16]
Development of curricula focused on formative situations – the role of the tasks in learning Physical Sciences in Basic School (Olga Melo) [Completed MSc]	3	3	Education/ Primary	[17] and [18]
Conception, implementation and assessment of a curriculum focused on the subject "Properties and Applications of Light" (Júlia Branco) [Completed MSc]	2	4	Education/ Primary	[19] to [23]
Students' Conceptions about Force - Development of a Strategy based on a Constructivist Teaching Model. Study in Cabinda (Angola) [Domingos Nzau] [PhD in final stage]	5	5	Education/ Primary	[24]
Identification of transversal traits, in the SER literature, relevant to teaching practices (Research project)	-	-	STER	[25] and [26]

5.8.1. The main results obtained

We present a summary of the results obtained in the empirical studies by type of results: i) efficacy of MFS-TST as a tool for curriculum planning and management quality in education; ii) heuristic value of MFS-TST for the research of relationships between teaching practices and learning; iii) heuristic value of MFS-TST in the analysis of the research in science education to identify transversal traits with relevance to teaching practices.

Efficacy of MFS-TST as a tool for curriculum planning and quality management in education

All eleven studies that used the MFS-TST to plan and manage didactic interventions in Physical Sciences classrooms, at different levels and contexts of education, have been successful at several levels: i) the participation of students in the courses/disciplines and in the assessment process; ii) positive academic results achieved by most students; iii) the development of a wide range of generic and disciplinary competencies; and iv) the engagement of students in their learning and also students' satisfaction with the educational experience provided. In particular, all studies reported gains made in the development of students' competencies compared with students from other similar classes but with other types of teaching. Furthermore, conceptual tests show results consistent with international results when teaching is oriented to promote conceptual learning.

The success, in terms of learning outcomes of students, obtained in the eleven case studies put in evidence the feasibility of didactic interventions based on teaching using the MFS-TST, as well as the heuristics efficacy of MFS-TST. We believe that MFS-TST can really help to design quality curricula to develop student knowledge, competencies and attitudes, because the students of the studies cited in table 5, who were taught based on the MFS-TST, had higher learning gains when compared to the control classes, both in terms of developing knowledge and competencies. It should be noted that these results occurred in all contexts of education (basic and secondary schools, as well as higher education) and in the training of teachers in different schools in Portugal and Angola.

In particular, studies conducted in higher education ([1] to [10]) have shown that education based on MFS-TST in the introductory courses of Physical Sciences (degree programs from universities and polytechnic institutes), do not have be centred around lectures. The contexts used must be thought in order to development the students' conceptual fields. The tasks and the respective situations must be planned carefully, because their formulation can help to engage and stimulate the students to carry them out and realize their importance for their learning.

The studies conducted in teacher training contexts ([11] and [12]) show that strategies of training based on MFS-TST develop the scientific literacy and self-efficacy of trainees.

Studies made in basic and secondary schools ([13] to [24]) has shown the crucial role of mediation in the quality of teaching ST.

Heuristic value of MFS-TST in the research about relationships between teaching practices and learning.

The success of implementation of formative situations, in the classroom, is highly dependent on the quality of the mediation provide by the teacher.

In particular, several results obtained support the notion that education based on MFS-TST, were the learning environment is based on autonomous work of students and the teacher mediation is diversified and centred on students, facilitates the development of high-level competencies in a wider number of students compared with traditional teaching. Even in classes that use the same tasks, the quality of teacher mediation makes a visible difference in the quality of teaching and in the competencies that the students developed.

The specification of available knowledge, competencies, knowledge and attitudes to develop, the physical situation, the problem, the activities of students, the resources, the tasks and the mediation is very useful, particularly because it ensures that none of these factors is forgotten and requires a more complete reflection in the conception and management of the curriculum, incorporating and articulating aspects that are often forgotten in more traditional curricular planning. In other words, the management of the curriculum (as a way to "decide what to teach and why, how, when, with what priorities, with what means, with what organization, with what results) was facilitated by the use of MFS-TST.

The way of proposing tasks and the arrangement of the classroom are sensitive aspects to the quality of teaching. The first relates to the quality of tasks, the autonomy granted to students to carry them out and the use that the teacher can do with the activity of students to put the teaching in another stage of abstraction and conceptual precision. The second relates to the objectives conditions for the teacher-student interaction to go beyond the merely rhetoric and with consequences to the students' learning.

Some results show that some aspects of the learning experience provided by the teaching are crucial for the development of certain students' competencies, particularly those related to the use of scientific knowledge in real situations.

Finally, the management of learning is highly dependent on the teacher's experience (which includes attitudes and knowledge of the teaching subject area) and has a decisive impact on the teacher mediation in the classroom.

As expected from the MFS-TST, the quality of teacher mediation strongly influences the learning that takes place in the classroom, changing its central characteristics.

Heuristic value of MFS-TST in the analysis of ST education research to identify the transversal traits with relevance to teaching practices.

The heuristic value of MFS-TST in the analysis of science education research (SER) has been demonstrated with the quality of the results obtained about the transversal traits of SER with relevance to the teaching practices of science teachers, which was published in the Journal of Research in Science Teaching, a top SER journal ([26]).

6. Bases for a Model for Effective Teaching for Intended Learning Outcomes in ST (METILOST)

Our Model for Effective Teaching for Intended Learning Outcomes in ST (METILOST) has a firm empirical base: our fifteen years long fieldwork on classroom activities. Some cases studies are described in sections 0 and 5.8 (see also annex I).

The theoretical base of METILOST is the MFS-TST presented in section 0.

We now build a broader and more comprehensive grounding, by asking the following central question: *are there worldwide fundamental learning outcomes?*

We restate the principles explained in section 5.2:

Principle A - The teacher mediation plays the main role.
Principle B - The fundamental entities are tasks and teacher mediation.
Principle C - It is not possible to deduce teaching models from learning theories.

Two additional principles will be assumed.

The first additional principle is related to *time*. The MFS-TST presented in section 0 made clear that teaching effort generally precedes learning effort. We need to go further. We state that it is necessary to distinguish the time lapse needed for learning outcomes and the time lapse along which teacher works, so that these outcomes can be reached. This distinction enlightens crucial features:

Learning does not occur simultaneously with teaching.
The concentration of the whole teaching effort in classroom is vain.
Learning is a lifelong process.
Teachers should settle on some type of students' learning follow-up after the initial teaching effort.
Students' mental evolution occurs in a chronology that differs from the teachers' one.

The second additional principle is related to the three *types of human learning outcomes* inspired from Wagensberg (2004):

Learning for immediate *action*. This extends from running away from a danger to piloting an airplane.
Learning to construct a *world-vision*. This extends from reading and calculating competences to an advanced scientific understanding and a well-built ethical culture.

Learning *to anticipate and* enterprising. This includes anticipating a problem or an occurrence; and enterprising in some scale and complexity to make a decision or build a technological artefact.

As shown in figure 8, there is a connection among learning time scale, general learning environment, and learning outcomes. Whether we want a certain type of learning outcomes we should select the right learning time scale and learning environment.

We thus add the following two principles:

Principle D - Teaching and learning times are distinct.

Principle E - The three main types of learning outcomes are: action, world-vision, and to anticipate and to enterprise.

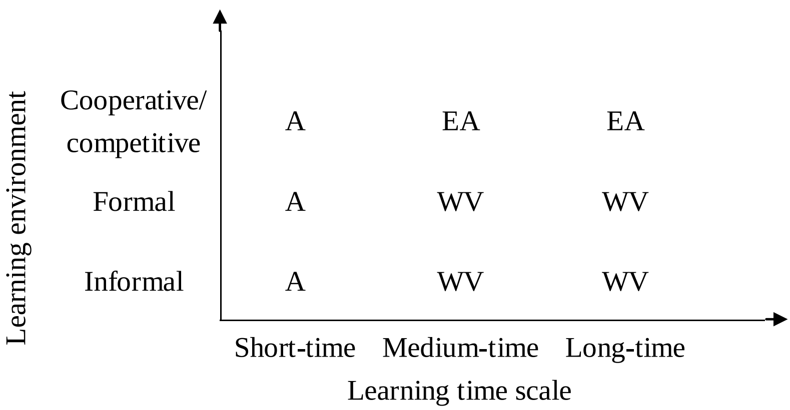
7. BUILDING METILOST

The effectiveness of teaching lies in the alignment between teaching modes and desired types of learning outcomes.

The MFS-TST is extended to METILOST by identifying the central aspects that can be changed to obtain adequate teaching modes.

From MFS-TST it follows the completeness of three central aspects: tasks, mediation and the articulation between both. Different choices about these factors will embody different teaching modes.

From *Principle E* it follows that there are only three fundamental teaching modes: training, mediation, and epistemic. The training mode of METILOST is oriented for learning to act. The mediation mode is oriented for learning to construct/acquire a world-vision. The epistemic mode is oriented for learning to anticipate/enterprise.



A – Action; WV – world-vision; EA – enterprise/anticipate

Figure 8. Relationships among learning time-scale, learning environment and type of human learning outcomes.

Thus, METILOST is built on the relationship between:

Three aspects: tasks, mediation and their articulation;
Three modes: training, mediation and epistemic.

7.1. Training Mode

In the training mode, single or articulated tasks are intended to allow an immediate action.

The mediation is based on a rigid structure of the teaching materials and an immediate feedback to the learner.

Learning outcomes that can be reached with this mode are, for example, handling laboratorial equipment and simple mental calculations.

Training mode may occur in contexts such as: workshops (carpenter, mechanic,.); sports, airplane pilot, safety and military training.

The assessment is based on immediate feedback and typical criteria are time and performance.

The requirements for the efficacy of training mode are:

The existence of tasks that allows feeling the epistemic object, for example using touch (to manipulated, to operate,) and vision (to follow-up what happens);
The existence and the quality of immediate feedback;
Good quality of the structure of the teaching sequence;
Good articulation between tasks and teacher mediation (mainly making explicit the pertinent conceptual field and providing a pertinent epistemic object and related resources).

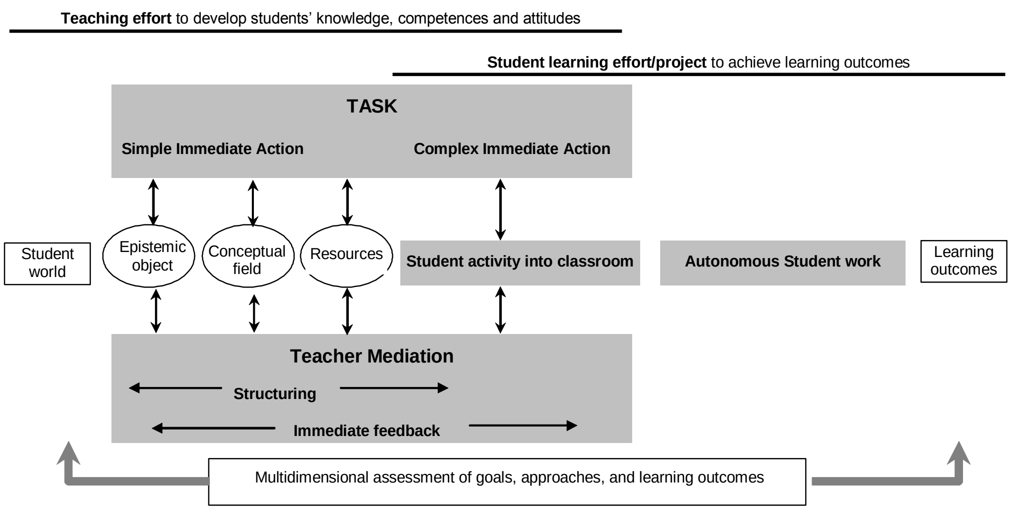


Figure 9. Training mode of METILOST

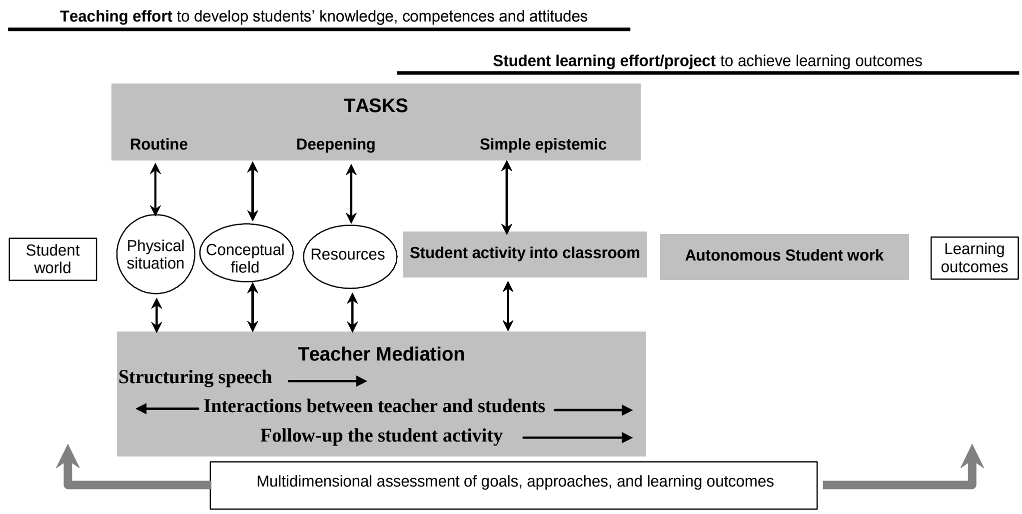


Figure 10. Mediation mode of METILOST

7.2. Mediation Mode

In the mediation mode, the tasks should allow the appropriation, the use and/or the manipulation of information and symbolic representations. The tasks are oriented to: i) developing abilities related to scientific or technologic procedures; ii) deepening the understanding of scientific and technological world-visions or processes.

The mediation is central in the sense that the intended world-vision is represented by the teacher. It is accomplished by structuring the teaching sequence, interacting frequently with students and following-up their developments.

Learning outcomes that can be reached with this mode may be, for instance: use of language; symbolic manipulation; understanding ST problems; solving ST problems.

Some contexts typically related to this mode are: formal education in schools; religious education; parental education; political activities.

The assessment is oriented to the correctness of the world-vision. It is done by teacher/master/authority. The main evaluation criteria are: rigor of the discourse; and deepness and correctness of the symbolic manipulation.

The conditions of efficacy in this mode are:

Clearness of the speech;

Relevance and quality of the interactions between teacher and students;

An adequate follow-up of the students' activities;

The use of tasks that reinforce, clarify or consolidate the intended world-vision;

Good articulation between tasks and mediation, namely by the means of: explicitly using the pertinent conceptual field; presenting a pertinent physical situation; and providing the necessary resources.

7.3. Epistemic Mode

In the epistemic mode, the tasks should be really epistemic tasks. This is to say that they should allow exploring unknown pathways with goals such as: looking for a solution to a problem or an answer to a question; making a project; inventing new problems, questions; outlining new projects to be developed.

The mediation in this mode is based on interactions among peers in cooperative and competitive environments. The teacher has a status of a special partner: one with an extra responsibility.

Examples of learning outcomes that can be accomplished within this mode are: understanding/anticipating what can happen in specific situations; and epistemic practices to produce knowledge, technology goods or services. In the words of Ugo Amaldi (2006), the learning outcomes are: scientific culture; wetware (the ability of brain to produce new ideas); and the production of new knowledge, technological products, goods or services

This mode may take place in contexts such as scientific communities, enterprises and other professional communities.

The assessment is external and is oriented for the quality of the products and of the process. Typical evaluation criteria are: satisfaction (of peers, public, society); adequacy of the knowledge to the epistemic object; aesthetic or ethical achievements and challenges.

The conditions of efficacy in this mode are:

To set good and really epistemic tasks;

Interactions among peers that are adequate and have good quality;

A good articulation between tasks and mediation. This requires: a good knowledge of the state of art on the field; to implement epistemic practices that are adequate to the problem/question/project; keeping as a permanent external referent the epistemic object.

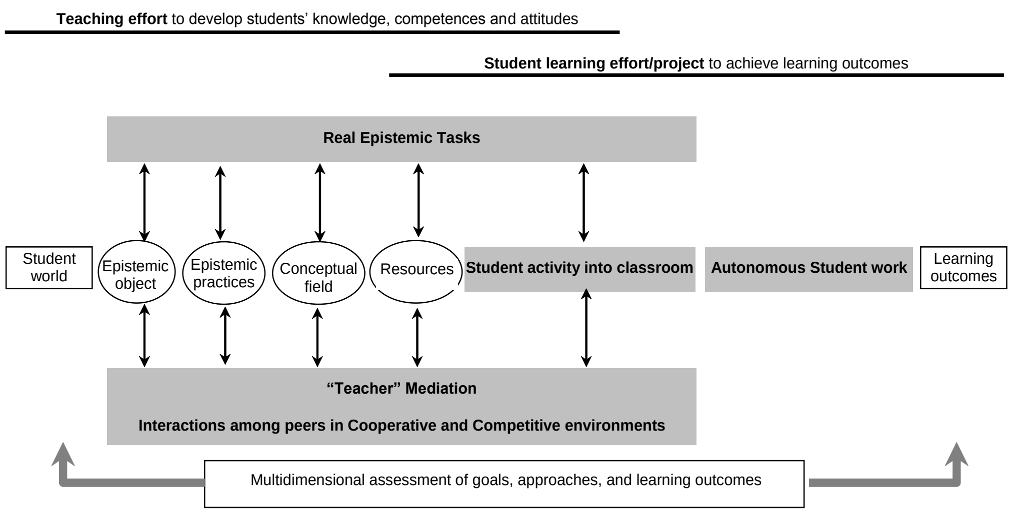


Figure 11. Epistemic mode of METILOST

8. METILOST AS CONSISTENT TOOL TO DESCRIBE, ELUCIDATE AND PREDICT: AN OVERVIEW

In this section we paraphrase some features of METILOST.

The set of three teaching modes of METILOST is a comprehensive tool that can be used to describe, to elucidate and to predict any feature for any formative situation and teaching method.

Each operating mode of METILOST can be adapted to any age range. Such an adaptation deals with tasks, mediation, and the articulation between them. They also deal with autonomy, interactions and conceptual fields according to the level of learning outcomes.

METILOST:

Shows that tasks and mediation are the permanent and fundamental entities in any formative situation. The teaching modes can be different but any formative situation or even any teaching method can be described or explain by one (or a set) teaching mode of METILOST.

Proposes guidelines about: how different teaching modes can be implemented; which are the more expectable learning outcomes for each mode; and how to identify the factors that maximize the efficacy of each mode.

Help when choosing a formative situation that presumably will be more adequate to learning aims, characteristics of students and other contextual features.

Stresses that it is possible to go from one teaching mode to another, when adequate and feasible. For instance, when working in the training mode, students and teachers are not impeded from going-ahead to another mode.

Clarify the importance of teaching modes, namely the epistemic mode, although the training and mediation modes have been historically privileged.

METILOST allows us to interpret common teaching models as variants of mediation modes. Differences reside in focus and learning outcomes.

"Teaching by transmission" focuses the structure of the teacher's speech in mediation. A significant and deep understanding by students is not the prominent learning outcome.

"Learning by discovery" focuses the structure of the tasks. It is a sort of empiricism in education. It overlooks that an object or a task is considered — if it is considered at all — with previous conceptual constructions and is performed with objectives and goals in mind. Teacher mediation tends to be virtually unconsidered.

"Alternative conceptions" approach prolonged the Kantian-Piagetian focus on an abstract epistemic subject. It overlooks differences between students. It overlooks that in a single student there are differences in thinking, expression, attitudes, abilities and knowledge mobilisation according to learning contexts, tasks, mediation and goals. It also overlooks that concepts, conceptions, models and words have contextual meanings and ranges of validity. It virtually does not take into account that learning is eminently a social process, where interactions between students and teacher mediation play fundamental roles.

"Conceptual change models" focus a particular type of interaction between teacher and students, oriented to cognitive conflicts and hurried conceptual changes. They overlook the importance of wide-ranging tasks and activities to help students to develop their conceptions in a continuous and meaningful evolution towards scientific knowledge. They also overlook two crucial issues referred below; the factor *time* and the *spiralled* nature of learning.

"Teaching by inquiry" concedes too little relevance to epistemic tasks and epistemic practices. These must be really epistemic if the epistemic mode is wished-for. They overlook the extra responsibility of teacher as a special partner in teaching and learning processes.

METILOST illuminates crucial issues such as:

How the factor *time* intervenes in formative situations. First, learning needs reinforcement and recurrence of processes. An educational action can not focus only on the time of a lesson: it should consider a structure of interaction between students and teacher that is extended along some time range. Besides, this structure of interaction should include places and time ranges that are wider than lessons in classrooms. As a specific instance related to time and teaching modes, we evoke that training modes usually lacks a follow-up. Assessment should be aligned with learning outcomes that occur after different times.

Learning is a *spiralled* route. In an individual life, several spirals concur simultaneously. Each one of them plays a relevant role. Informal and formal learning do spiral up together. Games may be an initiation to cooperative and competitive environments. Informal contexts may contribute to learning and provide motivation to further learning. School continues to be the main chain binding the knowledge and world views of successive generations. A systematic and structured personal effort is needed. Assessment, tests and examinations are necessary.

It is obligatory to consider the following question, even if it is not easily addressable: are the school systems — or a particular school/institution — prepared to accommodate the three modes with equal feasibility, adequacy, and dignity?

METILOST explains crucial features of education such as:

The necessity of the different formative processes, given the diversity of students and the respective life projects. It can be more productive to use a teaching mode that is more effective for the students' characteristics. No teaching mode is better that the others.

The efficacy and efficiency of the world vision mode in a pure state (without tasks) in countries with scarce economic resources.

The mediation mode is the most appellative in formal systems, because it provides authority, gives control to the teacher and is cost-effective. In some cases, it may be that the only feasible solution is a teaching made by barely prepared teachers supported by well designed textbooks.

The training mode is the most efficient to rapidly promote practical action.

The inefficacy and inefficiency of mediation mode to educate citizens who should desirably become knowledge producers and skilled task performers.

Some teaching modes are preferable for some intended learning outcomes.

METILOST can provide hints or anticipate guidelines about:

How each teaching mode requires functional spaces appropriate to the nature of the interactions that are necessary for each teaching mode.

How an informal and rich learning environment is not enough for students to develop interesting learning outcomes; it is necessary time and personal effort, as well as the presence of teacher mediation.

Which tasks to choose so as to develop students' competencies in the scope of specific modes: exemplar or routine tasks (training mode); traditional or exploring tasks (mediation mode); epistemic or project tasks (epistemic mode).

Which system of formation to implement, e.g.: i) centered on teacher; ii) alternating cycles that blend the three teaching modes; iii) successive cycles, each one of them centered in a specific teaching mode.

How to shape and implement a specific teaching mode, depending on aims, objectives, cultures, learners' engagement and epistemic object.

How to conceive a functional project for an available space and how to model and construct it accordingly to each operating mode and the nature of tasks and interactions.

How to be a knowledge-producer teacher, working with formative situations in epistemic mode, epistemic objects, epistemic practices and collaborative and competitive forums.

The METILOST is a general model of teaching ST. However, in this level of generality we can understand better what is essential to the ST teaching and the different leaning outcomes that are possible to obtain with each teaching mode of METILOST.

METILOST is a powerful tool and a comprehensive model with internal and external consistency. This claim found favour in the overview hitherto presented. We reinforce it in the next section.

9. METILOST as a Consistent Tool to Describe, Elucidate and Predict: Teaching and Research

9.1. Teaching Methods

We analyze here the efficacy of different teaching methods characterized in the ST-ER following their characteristics as given by M.J. Prince and R. M. Felder (2006, 2007). The analysis is shown in table 6.

In the analysis we use the efficacy conditions identified for each teaching mode of METILOST (section 7). Assuming that a given teaching method can be oriented to any teaching mode of METILOST, we analyse a teaching method using all efficacy conditions of the three teaching modes. Besides, in the analysis, we assume that there are some conditions of efficacy that are fundamental. That is, if a teaching method is effective in a teaching mode of METILOST, thus it must verify all fundamental efficacy conditions of this teaching mode of METILOST.

Results of the analysis of teaching methods' efficacy using the METILOST:

Inquiry, Problem-based, Project-based and Case-based

For training mode of METILOST these teaching methods do not verify two fundamental efficacy conditions, and verify conditionally the other efficacy conditions, including a fundamental one, dependent from teacher mediation.

For mediation mode of METILOST these teaching methods do not verify completely any fundamental efficacy condition, but verify conditionally all efficacy conditions, including the fundamental ones, dependent from teacher mediation.

Table 6. Analysis of teaching methods using conditions of efficacy of METILOST

Methods		Inquiry	Problem-based	Project-based	Case-based	Discovery	JiTT (a)	Expository	Training
Conditions of efficacy									
Training mode	(F) Existence of tasks that allow the articulation between touch (to manipulated, operate,…) with epistemic object and vision (to see for follow-up what happens)	P	P	P	P	P	N	N	Y
	(F) Existence and quality of immediate feedback	N	N	N	N	N	Y	N	Y
	(F) Quality of the structure of the teaching sequence	N	N	N	N	N	P-D	Y	Y
	Articulation between tasks proposal and teacher mediation providing the adequate resources	D	D	D	D	D	D	D	D
	Articulation between tasks proposal and teacher mediation through the interaction with the epistemic object	P-D	P-D	P-D	P-D	P-D	N	N	D
	Articulation between tasks proposal and teacher mediation using the adequate conceptual field	P-D	P-D	P-D	P-D	P-D	P-D	P-D	D
Mediation mode	(F) Existent of tasks that reinforce, clarify or consolidate the world-vision taught	P	P	P	P	P	P	Y	N
	(F) Structure and clearness of the speech	P	P	P	P	N	Y	Y	N
	(F) Following-up of the students activity	P-D	P-D	P-D	P-D	N	P-D	P-D	P-D
	Relevance and quality of the interactions between teacher and students	P-D	P-D	P-D	P-D	P-D	P-D	P-D	P-D
	Articulation between tasks proposal and teacher mediation providing the adequate resources	D	D	D	D	D	D	D	D
	Articulation between tasks proposal and teacher mediation using with physical situations	D	D	D	D	D	D	D	D
	Articulation between tasks proposal and teacher mediation using the adequate conceptual field	D	D	D	D	D	D	D	D

Table 6. (Continued)

	Methods	Inquiry	Problem-based	Project-based	Case-based	Discovery	JiTT (a)	Expository	Training
Epistemic mode	(F) Existence of real epistemic tasks	P-D	Y	P-D	Y	Y	N	N	N
	(F) The pertinent and quality of the interactions among peers	P-D	P-D	Y	P-D	N	N	N	N
	(F) Using and/or develop epistemic and/or axiological practices	Y	P-D	P-D	P-D	N	N	N	N
	Articulation between tasks proposal and teacher mediation using the epistemic object as external referent	D	Y	P-D	Y	N	N	N	N
	Using the state of art of the conceptual field	P-D	P-D	P-D	P-D	N	N	N	N
	Articulation between tasks proposal and teacher mediation searching the adequate resources	D	D	D	D	D	D	D	D

(a) Just in Time Teaching

(F) –Fundamental condition of efficacy; Y – yes; P – possibly, D – it depends; N - no

For epistemic mode of METILOST these teaching methods verify completely only one fundamental efficacy condition and conditionally two fundamental efficacy conditions (dependent from teacher mediation). The others efficacy conditions depend from the teacher mediation characteristics.

So, the inquiry, problem-based, project-based and case-based teaching methods: i) are not effective for learning to act, ii) have an efficacy for learning to acquire a world-vision conditioned by teacher mediation characteristics; iii) have some efficacy to learning to enterprise/anticipate, although that efficacy is strongly dependent of teacher mediation characteristics.

Discovery

For training mode of METILOST the discovery teaching method does not verify two fundamental efficacy condition, and verify conditionally the others efficacy conditions, including one fundamental, dependent from teacher mediation

For mediation mode of METILOST the discovery teaching method does not verify two fundamental efficacy conditions, and verify conditionally the others efficacy conditions, including one fundamental, dependent from teacher mediation.

For epistemic mode of METILOST the discovery teaching method does not verify four efficacy conditions, two of them fundamental ones.

So, the discovery teaching method is not effective for: i) learning to act, ii) learning to acquire a world-vision, iii) learning to enterprise/anticipate.

JiTT

For training mode of METILOST this teaching method does not verify two efficacy conditions (one of them fundamental), and verify other fundamental efficacy condition. The others efficacy conditions depend from teacher mediation

For mediation mode of METILOST this teaching method verify two fundamental efficacy condition. The others efficacy conditions, including one fundamental, depend from teacher mediation

For epistemic mode of METILOST this teaching method does not verify a great number of efficacy conditions, including all fundamental ones.

So, the JiTT teaching method: i) is not effective for learning to act, ii) has an efficacy for learning to acquire a world-vision conditioned by teacher mediation characteristics; iii) is not effective for learning to enterprise/anticipate.

Expository

For training mode of METILOST this teaching method does not verify three efficacy conditions (two of them fundamental).

For mediation mode of METILOST this teaching method verify one fundamental efficacy condition. The others efficacy conditions, including one fundamental, depend from teacher mediation

For epistemic mode of METILOST this teaching method does not verify a great number of efficacy conditions, including all fundamental ones.

So, the expository teaching method: i) is not effective for learning to act, ii) has an efficacy conditioned by teacher mediation characteristics for learning to acquire a world-vision; iii) is not effective for learning to enterprise/anticipate.

Training

For training mode of METILOST this teaching method verify the three fundamental efficacy conditions.

For mediation mode of METILOST this teaching method does not verify two fundamental efficacy conditions. The others efficacy conditions, including one fundamental, depend from teacher mediation

For epistemic mode of METILOST this teaching method does not verify a great number of efficacy conditions, including all fundamental ones.

So, the training teaching method: i) is effective for learning to act, ii) has reduced efficacy for learning to acquire a world-vision and still conditioned by teacher mediation characteristics; iii) is not effective for learning to enterprise/anticipate.

9.2. Research about Classroom Teaching—The Case of Engineering Education

A variety of good teaching strategies, and research studies that support them, can be found in engineering education research. Some of the cases encountered can be incorporated into the METILOST previously explained. We believe this framework could easily help in explaining the gains reported on some of them. Science or engineering teachers may try to implement some aspects of this METILOST and incorporate the developments to improve their performance over the years, by beginning to structure their courses based on the METILOST, as presented in section 7.

In real life a professional engineer is evaluated by his performance and competence, and is asked to act in different and complex situations that involve analyzing, interpreting and anticipating results, and he should be prepared to do so in college (Perrenoud, 2003). This will only be accomplished if knowledge becomes operative (Astolfi, 1992). For this to happen students should work with knowledge so that it becomes meaningful. Therefore, learning should be directed to the development of competencies that will improve professional performance. In order to do so, teachers must carefully plan their classes around students' knowledge and develop activities that provide opportunities for the growth of both their knowledge but also their competence and their skills useful for their future daily work in other contexts.

Engineering courses all over the world prepare themselves for evaluations of Accreditation Boards Comities (Felder & Brent, 2003; McCowan & Knapper, 2002, Terry, *et al.,* 2002), such as ABET accreditation, in which one of the main concerns is the quality of the graduates in terms of competences acquired, as one can see in one example present in Felder and Brent (2003) when describing these criteria:

Ability to apply knowledge of mathematics, science and engineering
Ability to design and conduct experiments, as well as analyze and interpret data
Ability to design a system, component, or process to meet desired needs
Ability to function on multidisciplinary teams
Ability to identify, formulate, and solve engineering problems
Understanding of professional ethical responsibilities
Ability to communicate effectively
Broad education necessary to understand the impact of engineering solutions in a global and societal context
Recognition of the need for and an ability to engage in lifelong learning
Knowledge of contemporary issues
Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

One knows that some institutions face difficulties in order to obtain such evaluation from their graduates. By organizing courses and degree cycle/programs following the METILOST, not only these competences, skills and attitudes could be better developed as easily evaluated, and the outcomes specified in Felder and Brent's work (2003a) could have an (almost) immediate response.

In spite of there being many areas in engineering, these context bases in the METILOST should prove adequate, providing students more awareness of their future profession an being an extra effort to show and motivate the students to their area of expertise. Designing the curriculum around those contexts of use, this framework provides a way of teaching engineering, even at the introductory courses.

The development of those skills and competences will allow students to accomplish more demanding goals in subsequent courses, since they have been practicing those ideas from the beginning.

Lifelong learning is another subject that worries the engineering professionals (Briedis, 2002). Not only could the METILOST easily be adapted to create post-graduate courses in which they can develop expertise, as the students who develop in this learning environment could be more motivated to learn throughout their lives.

The relationship between college and industry, so dear to engineers (Brisk, 1997), may be accomplished if, for instance, some of the contextual fields are worked out in formative situations as projects, in which professional competences will be better developed. Senior students would gain experience and developed the necessary conceptual fields required, if the course is organized in this way.

A difficult point will be the moment of change, since these curricular developments based on METILOST represent a cut off with traditional teaching, mainly in introductory courses, in which the extensive syllabus frequently tends to lead to more expositive lessons. The contexts of use must be thought to reach the conceptual fields of the students in order to develop the intended contents. Problems/situations must be carefully planed as well, so they can motivate and stimulate students in completing them (not too difficult, nor too easy) and feel a real gain by solving them.

And, as already stated, the success of this implementation in classroom is very much dependent on the quality of the mediation provided by the teacher.

We believe that the METILOST in epistemic mode can indeed be powerful in improving engineering students competences, not only in the first years, in introductory courses, but also throughout the entire course in more advanced courses: i) by always considering what the students' already know (from previous courses or from in their life experience), by facilitating an integration of knowledge; ii) by providing students with real tasks in or out of classrooms, we are preparing them for their real profession of engineering, by training them to solve real problems; iii) in developing diversified mediation, teachers will not only, as we have seen, be helping students preparing for their major but also be helping them with the convenient social competences every engineer must possess; iv) by constructing the knowledge the students will be preparing themselves, not only for their final examinations, but to apply it throughout their professional careers; v) by inducing students in autonomous work, we will be preparing our students to become competent engineers and not simply straight A students, adept to continue learning throughout their lives. These items are based on METILOST in epistemic mode and can be implemented in the curriculum of a course or, in a broader perspective, in the entire degree cycle/program.

10. Generality, Relevance, Potentials and Limitations of METILOST

10.1. A Synopsis of METILOST

Three practical tools were developed: (i) the conceptual field network; (ii) the PERT diagram of formative situations; (iii) and the FS specification table. We also developed the concept "mediation in action" to clarify how to make mediation operational. Other researchers have asked us to use the FS framework in other educational contexts, which is a clear indication of its potential for research.

METILOST synthesizes and articulates three main contributions: (i) STER in the last four decades; (ii) the fifteen years long work done by the authors on observing and describing classroom activities of students and teachers; (iii) twenty six research studies done in the last nine years by the authors with an early version of METILOST (see section 0 - MFS-TST). These researches were conducted at several educational levels (basic, secondary level and university) and in several physics and chemistry themes.

METILOST can be used to describe, to elucidate and to predict about any formative situation or teaching method.

Still, it is not a recycling of the old didactical triangle student-knowledge-teacher. In fact, student and knowledge are the two poles of the epistemological structure of knowledge learning and the teacher is embedded in the binding of those poles to induce ways of learning.

METILOST allows teachers to concentrate on two key-concepts (tasks and mediation) and subsidiary concepts (e.g., teacher effort, student learning effort student world, learning outcomes, multidimensional assessment and autonomous students work). The articulation between tasks and mediation results in a specific student activity and is shaped by context, conceptual field and resources. The context may be different as the teaching mode: i) epistemic object for training mode; ii) physical situation for mediation mode; iii) epistemic object and epistemic practices for epistemic mode (see figures 4, 9, 10 and 11).

The METILOST is conceptually economic. It has only a few key-concepts. This is important because it has been shown (Miller, 1956) that the human work-memory can work simultaneously with a maximum of 7±2 units or chunks of information. METILOST deals with only 8 deeply inter-related chunks of information.

METILOST provides a reading grid of STER papers to help teachers to choose what may be more relevant for specific learning outcomes and students' characteristics.

Thus, METILOST: aids teachers to identify directions for their own professional development; aids teachers to make students' learning effective; and points out some directions for future studies in STER.

10.2. Relevance and Potential of METILOST

METILOST allows understanding that there are different types of teaching, according to the role and characteristics of tasks and mediation and their relationship. These may happen in a substantially different way from what was planned. METILOST explains both what is planned and what actually happens and can help in adjusting the two realities.

METILOST allows the curricular planning of a subject, topic, curricular unit or cycle of studies. It also helps teachers in the management of classroom teaching.

METILOST clarifies there is no ideal type of teaching. Different types of teaching may be useful to different purposes; and different types of teaching may be combined in a given context. Nevertheless, each type or combination must be adapted to the student's characteristics and the desired learning outcomes.

A certain type of education is determined by the actual articulation between the tasks proposed to students and the actual mediation performed by the teacher. The educational potential of a task will be drastically reduced if the mediation is inadequate to it.

METILOST can also help teachers to make related choices about resources, conceptual fields and network of contexts.

METILOST is useful in teaching ST and also in the research about teaching practices. It allows integrated approaches about relationships between teaching practices and effective learning, and also between teaching practices and curricular management.

Teaching and learning ST in the classroom are complex and multidimensional processes. Thus, the related research needs a global perspective. There is already a noticeable trend in STER to cross several traditional research lines (Martínez Terrades, 1998), or trying to capture the complex nature of ST teaching practices (Alsop, Bencze & Pedretti, 2005). On the other hand, teachers' approaches are based on their own global perspective, which is influenced by factors such as personal believes, experience, teaching and learning conceptions and epistemological view of ST. Thus, each teacher must articulate the different results from STER and METILOST can provide an effective way to integrate a multitude of research contributions. This should help each teacher to integrate STER knowledge into his own practice.

10.3. Some Limitations of METILOST

METILOST is a work in progress: in spite of its relevance and potential there are, certainly, aspects that should be clarified, or other that can be incorporated.

METILOST still has some limitations. For example, some contributions of STER are present only implicitly (e.g., gender and ethnic issues).

METILOST requires some conditions to an appropriate use. It must be used in a holistic way, because each key-concept is deeply inter-related with all the others. Ideally, the entire curriculum should be designed and implemented according to this framework if optimal results are to be achieved. Besides, it only works if a cordial climate has been created in the classroom.

10.4. METILOST Can Guide the Research on ST Teaching to New Possibilities

STER may elucidate better the status of specific ST concepts or the historical context of their production, thus contributing to the advancement of knowledge of how to teach and learn them. Another important direction for research is the teacher mediation and its specific issues: space and work organization, classroom climate, classroom talk, information flow, student's work autonomy *versus* teacher support, teacher awareness.

METILOST is still in a developing process. It has some weaknesses. More research is needed to illuminate/elucidate i) the managing of the curriculum of courses at different levels of education; ii) the preparation and/or the support of the professional development of teachers or other professionals; iii) the assessment of the quality of ST teaching; iv) the multiple aspects of relationships between teaching practices and students learning, in and out classroom and in different time scales.

METILOST may be used in formal, informal and professional learning contexts. The focus is in student/apprentice learning and in what the teacher/instructor must do in specific contexts to promote effective and lasting learning. How can the research efforts, using METILOST, elucidate this branch of activity?

METILOST articulates theory and practice. It is based on STER and is supported by several empirical specific studies that used our own MFS-TST. It is centred on students and takes into account that any system of learning has specific goals about learning outcomes. It makes explicit and emphasizes what is central in teaching, in accordance to the desired learning outcomes. It allows teachers to focus on key aspects when looking to base their teaching in STER: tasks, mediation, real activity of student, student's available knowledge, learning outcomes, assessment, develop competencies, network conceptual field, resources and STS context. It allows us to focus attention in the fundamental key-aspects of the curriculum: tasks, teacher mediation and students' assessment. How can the METILOST incorporate the different contributions of STER in these particular issues?

Another possibility is to explore how the METILOST may be used to evaluate ST curricula and curriculum management in classroom, independently of their theoretical grounding.

10.5. Some Contributions of METILOST

First contribution. METILOST clarifies that there is not an ideal teaching method, nor even an ideal teaching mode of METILOST. Different types of teaching are useful for different purposes. A combination of several types of teaching may be needed. Each combination depends on the type of students and the learning outcomes intended (related with aims and goals of a specific case). This is the broad part of the first contribution of METILOST. The clear-cut part is: i) METILOST allows to predict which learning outcomes are reasonably expectable when a specific teaching method is used; ii) METILOST is a powerful framework to analyse the effectiveness of any teaching method to promote one or more types of learning (action, world vision or anticipate/enterprising).

Second contribution. METILOST clarifies: how tasks can be interrelated with mediation; how these interrelations determine a teaching mode; and how a teaching method is linked to the learning activity induced. A specific method of teaching is characterized by the actual articulation between tasks proposed to students and the actual mediation done by teacher. So, the actual learning activity induced may be changed by a subtle but fundamental change of mediation type. METILOST can predict the type of teaching if we know the type of task to propose to students and the mediation style chosen. It can also predict the changes in teaching type intended if some changes occur in mediation style.

Third contribution. METILOST helps teachers to make fundamental teaching choices about: type of tasks; type of mediation; and articulation between them through adequate context, resources and conceptual field network. With METILOST it is possible to plan the curriculum of a theme, a curricular unit or a study cycle. METILOST also helps teachers in the management of the curriculum. METILOST can illuminate many possibilities of developing ST teaching, creating cycles of teaching methods privileging in certain phases one mode of METILOST. It is possible to create complex teaching plans to reach a large range of learning outcomes. METILOST can also be a tool to invent new teaching methods.

Fourth contribution. METILOST allows a portrayal of teaching that will permit an improvement in the quality of teaching and learning through formative assessment.

Fifth contribution. METILOST as a theoretical framework may be used to: i) plan and/or manage the curriculum of courses from different levels of ST education (in particular in engineering, in any cycle of the Bologna paradigm); ii) prepare and/or support the ST professional development; iii) evaluate the quality of teaching or courses, even if they are grounded on other theoretical frameworks.

CONCLUSION

METILOST is the model we propose for teaching ST, a model that allows designing the curriculum and managing it in the classroom for a more effective teaching, according to the intended learning outcomes and to guide research on teaching ST to new possibilities.

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ANNEX I. REFERENCES OF EMPIRICAL STUDIES THAT USED THE MFS-TST

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Chapter 3

PARTICIPATING IN THE HYPERLINKED CURRICULUM

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ABSTRACT

Many higher education faculty members find themselves with the opportunity or requirement to design a new course, or to redesign existing courses or programs. In such situations they have a number of options for how to proceed, but may be unaware of these options. And despite the recommendations and examples provided by organizations such as the Mathematical Association of America, we lack objective guidelines for making curricular decisions and for evaluating potential curricular changes. Additional complications are encountered in the hard sciences, where evaluation of hypotheses typically occurs only after rigorous experimentation. With many curriculum experiments resulting in ambiguous or anecdotal data or lacking data whatsoever, we are faced with making decisions under a great deal of uncertainty. In this chapter, we will discuss five models for curriculum development that are founded on different concepts of the learning experience. Each is unique in its approach and each pairs with different types of learning goals and objectives. Like all curriculum models, these are an attempt to share with students some underlying knowledge structure, a structure that is essentially a mathematical object known as a graph or network. They can be generated through a kind of mind map or concept map and possess complex inter-relations among the components which often require a three-dimensional model to fully visualize. To construct any curriculum then requires that we take this complex structure in three spatial dimensions and project it into a single temporal dimension so that students can experience the curriculum over time. This projection is not unique, except for the simplest of knowledge structures. Thus, all decisions about curriculum development become equivalent to a single geometric question: How do we choose the best projection from which to view the curriculum? An alternative approach, the one taken in this chapter, is to go beyond a fixed curriculum or static projection to expose students to a hyperlinked curriculum. Rather than hiding the complexity of knowledge and its connections to the students, the hyperlinked curriculum is generated by students under the constraints, guidance, and support of teachers and in collaboration with others. These teachers are in turn supported

by each other, linked together by administrators who seek to guarantee appropriate opportunities for all learners.

INTRODUCTION

Curriculum development consumes a great deal of time at all levels of education. Presumably, this means that we are all working to develop and evaluate our curriculum in order to improve student learning and success. Many of us serve on committees for curriculum and instruction. This has produced a variety of metaphors: curriculum as a meal, curriculum as a production line, curriculum as a race or course to be followed, but what exactly is meant by the word "curriculum"? Beauchamp points to a multitude of definitions for the word which does not seem to have narrowed in the intervening decades. He does dichotomize "curriculum" from "instruction" though, and distinguishes the work of curriculum theory into curriculum design and curriculum engineering:

> The area of curriculum design involves all of the potential choices for the selection of culture content to be incorporated in the curriculum, alternative ways of organizing that culture content, and other supporting information such as alternatives in goal statements and/or use statements. The process dimension may be classed as the area of curriculum engineering. The area of curriculum engineering involves the processes of curriculum planning, implementing, and evaluating and including the problems of leadership and role behaviors. (Beauchamp, 1982, p. 25)

This is a remarkably comprehensive definition, and seems to encompass all components that anyone has ever included. A more succinct definition is given by Hubball and Gold (2007) who claim it is

> a coherent program of study… that is responsive to the needs and circumstances of the pedagogical context and is carefully designed to develop students' knowledge, abilities, and skills through multiple integrated and progressively challenging course learning experiences.

This definition is dense with concepts. In attempting to unpack these, I was surprised more than once at differences between what I have been doing when engaged in "curriculum activities" and what seems to be considered important. These distinctions are captured best by five words: Coherent, Responsive, Contextual, Integrated, and Challenging. But much of the curriculum literature, including Beauchamp's definition above, seems to focus on two phrases: "program of study" and "carefully designed".

In keeping with the recursive, self-similar characteristics of the fractal curriculum (Fowler, 1996) I will take the phrase "program of study" to mean a variety of things, all at different scales, with concepts freely moving across the boundaries from one scale to the next. This open system could be a single course, a single unit within a course, or an entire degree program. At each of these scales, one must engage in curriculum development to "carefully design" the experiences that students will have. This idea could, at first glance, lead us to restrict our view of curriculum to the syllabus or product approaches (Smith, 2000). These models focus on a pre-determined sequence of learning experiences (syllabus model) or on designing experiences to produce a particular pre-determined student learning outcome (product model). However, the process and praxis models are more important if we look at the rest of the definition: for a curriculum to be responsive and contextual we cannot design it in isolation from the students. The curriculum must be a process of development, where students learn how to learn and evaluate and challenge the ideas they encounter and their relationship to those ideas. It must also be practical, drawing on the real world for problems and returning to the real world for applicability, usefulness, and importance. It is this context that provides meaning for the curriculum and ties the curriculum together. We will make some use of the syllabus and product models in order to explore the notion that underlying any body of knowledge is a structure that connects the concepts relationally through a mathematical object known as a graph. In a radical perspective shift, though, we will turn away from expert graphs that model the knowledge and focus on developing a curriculum that allows students to build, explore, and modify their own graphs to represent their knowledge and learning experiences.

In many ways, though, the syllabus and product curriculum models still represent the state of the art. For example, the "guaranteed and viable curriculum" (Marzano, 2003) focuses on narrowing down the expectations we have for students and getting some of the educational stakeholders together to reframe the curriculum around the essential "power standards." But the students are left out of this process. It is still a model of curriculum designed to provide a standardized outcome, common to all students. But a living, breathing curriculum needs to be structured to allow everyone to gain meaning from it. At the same time, the curriculum must be coherent, focused on some central theme to provide learners an overarching picture or scaffold for their learning. This coherence can be explicit, in the form of developmental, cross-connectional, or purpose-driven coherence (Ahlgren and Kesidou,1995). or it could be emergent as a result of the learner's interaction with the experiences. Regardless, coherence is critical for helping students transfer their knowledge from one learning context to others.

We are now left with two more words to unpack. The idea that the curriculum should challenge students is not new, but it certainly does not seem to be used as often as we, or the students, think. Students are often not challenged in an honest way; they are required to meet artificial, academic challenges that bear little resemblance to the world at large. They are challenged to memorize vast quantities of facts and procedures. What we need for the current century is a curriculum that challenges students to think about real problems, reflect on ideas, and connect them to find and evaluate solutions. To do this genuinely, the problems we pose must be integrated across disciplines. Current curriculum design is based around the concept of discipline-specific knowledge and the accumulation of facts with a splash of higher order thinking thrown in; it is a model inherited from scientific management methods based on creating plans for learning many small, independent skills. These lists are created outside the educational environment in which they will be implemented (Smith, 2000). But the real world consistently refuses to fit into these discipline boxes, yielding experiences and problems that are so multidimensional that the reductionist approach of breaking them down may not be useful. Increasingly, programs are emphasizing information literacy skills, writing skills and quantitative reasoning skills across the curriculum. And while this may be a useful intermediate step that builds from current, discipline-based models for faculty preparation and development, what is needed is a curriculum where students have opportunities to design their own experiences and develop their own plan in exploring complex, interconnected topics.

What will emerge from our investigation is a model of curriculum focused on learning, not teaching. The model will be a type of meta-curriculum that views curriculum as a combination of experimentation, reflection, and collaboration. It will start with goals and methods and explore different ways to achieve these while monitoring and collecting data about what is happening, not necessarily whether we are getting desired results. It acknowledges the uniqueness of each educational context and each student. This chapter will not attempt to explore the historical roots of curriculum theory or the general processes of curriculum development. Others have more ably done this (c.f. Pinar, Reynolds, Slattery, and Taubman, 1995). Instead, it will focus on curriculum development in relation to the participants. *Students* in the curriculum should have an opportunity to participate in new experiences, and from these, to develop new understandings about the world, others, and about themselves. *Teachers* set up the experiences, guide the students when they need help in these experiences, and provide feedback to help students deepen their understandings and make more and deeper connections. *Administrators* provide teachers the materials and resources they need in order to carry out their role in collaboration with other teachers, by providing experiences from which teachers can develop new understandings.

This curriculum model will, I suspect, lead to some discomfort because it is explicitly built on letting each student develop their own learning in a very individual manner. In the current climate of standardized testing, this may prove to be a hard sell. However, students have always learned different things from the same curriculum. Not every student achieves the same grade, connects with the same concepts, or comes out with identical understanding. And we cannot forget that students also learn things we never intended them to (Reynolds, 2005, p. 270). No curriculum can avoid this; instead, we should build a curriculum that embraces it. Many faculty I speak with also suggest that this generation's students are weaker than those of previous generations. My response is simple: we are currently collecting more formative assessment data now, so we are just now seeing these differences in individual students as they develop, rather than at an arbitrary summative endpoint, as was more typical in the past. The only alternative to this differentiated curriculum would be a plan to explicitly indoctrinate everyone into the exact same learning for the sake of pure conformity rather than actual learning and development. One example is marching in the military, which is explicitly designed to disrupt communication across the brain hemispheres and inhibit deeper thought and reflection so that all participants join in a literal lock step (Wilder, 2007, p. 10-11). I will make the bold assumption that our goal in education is not consistent with such a uniformity of thinking and acting.

This chapter will not attempt to catalogue all the issues and connections to the concept of a curriculum. In many cases, it will freely cross the boundary between curriculum and instruction (if there even is a boundary). And while the examples are drawn from personal experience in the context of higher education, I believe that the curriculum model that emerges will be equally useful at all levels of education for helping develop new and more deeply meaningful learning experiences. This development process will involve a great deal of work over many iterations and scales of effort. Kimpston and Rogers (1986) have comprehensively listed the variables involved at each stage of the curriculum. But their list sidesteps the most important question: While they identify variables that correspond to five of the basic questions one can ask (who, what, when, where, and how) they fail to consider *why* we need to design a new curriculum.

Are we trying to improve student performance? Are we trying to prepare them to be lifelong learners in a new environment? Is justice and equality paramount: do we want all of the students to get the same experiences or perform at the same level? Are we changing the curriculum in order to meet external requirements? Or perhaps our objective in changing the curriculum is more about student motivation and engaging them in learning. While the reason for the curriculum change may seem irrelevant, it will impact each of the other aspects of curriculum, especially the evaluation of its success. Throughout this chapter, keep in mind the question of why; I claim that the curriculum model I present, the hyperlinked curriculum, is robust enough apply to any of the possible answers to why we are changing the curriculum. Regardless of the specific reason for the change, it must be intentional. We must clarify our goals and our notions of who our students are, "designing curriculum around these two factors, and assessing our success in reaching these objectives" (Zundel and Mengel, 2007, p. 77). Throughout, we must also remember that such assessments are not identical to assessments of students, although that is one component.

Scaffolding is one of the most important activities that can occur in any curriculum or learning experience. In that light, I provide the following preview of what is to come in this chapter. Along the way, there will be occasional tangents; readers are encouraged to replace these with their own experiences to interact with the notion of the hyperlinked curriculum. To clarify some of the main approaches to mapping a curriculum from the space of ideas to the temporal realm in which learning must occur, we will explore five models for curriculum development that are founded on different concepts of the learning experience. Each is unique in its approach and each pairs with different types of learning goals and objectives. What all of these models have in common is an attempt to share with students some underlying knowledge structure. These structures are essentially a mathematical object known as a graph or network. They can be generated through a kind of mind map or concept map and possess complex inter-relations among the components which typically require a three-dimensional model to fully visualize. To construct any curriculum then requires that we take this complex structure in three spatial dimensions and project it into a single temporal dimension so that students can experience the curriculum over time. Since this projection is not unique, except for the simplest of knowledge structures, we are left with a number of possible curricula to implement. Thus, many previous curriculum development projects have focused on what amounts to a single geometric question: How do we choose the best projection from which to view the curriculum? This inevitably leads to considering what we mean by "best." Such a loaded word will be interpreted differently by almost every stakeholder, leading to a myriad of possible interpretations and competing outlines for a course of study. I believe a more productive direction that looking at different projections (which always lose information) is to develop a new type of curriculum, one that allows students to explore and construct their own naturally existing, three-dimensional knowledge maps, rather than follow a predetermined path through someone else's knowledge structure. I refer to this new curriculum model as the *hyperlinked curriculum*, which we will discuss in detail, carefully examining the processes of building, teaching, and learning in such a model. And while I have not fully experienced or implemented the hyperlinked curriculum in an educational setting, I have seen glimpses of it emerging in a few examples that we will consider before wrapping up the discussion.

SOME MODELS OF CURRICULUM STRUCTURE

Human knowledge is about connections among ideas and the fruitful interplay of these ideas and connections. Even though we are constantly rethinking all of our past experiences in light of present circumstances and simultaneously projecting these ideas into the future, our experiences are always ordered temporally in a linear fashion. This is true of all experience, so learning and teaching are not exempt. Thus, regardless of the approach taken to designing curriculum, we are left designing a sequence of activities and experiences that will unfold sequentially in time.

For this reason, the following five models will provide some basic examples of sequential organization that can be used at any level of curriculum development. These examples (applied to individual courses) illustrate approaches that I have seen or used. In calling for a Scholarship of Curriculum Practice, Hubball and Gold (2007) imply that faculty should be making curricular decisions in a conscious and meaningful way, that they should be evaluating these curricular decisions in a variety of ways, and that the results of the studies should be shared. Hughes (2007) shares this concern, highlighting that evidence-based decision making, while at the cornerstone of many of our disciplinary traditions, is often missing from our curricular decisions. However, in the absence of models and examples of curriculum design, communication and evaluation become impossible. Indeed, it may not be possible to even frame the questions we need to ask or make significant changes to the curriculum beyond simply tinkering with "what we teach." While the following models are focused at the course-design level, each could be applied to a larger curriculum, such as a four-year post-secondary degree. In that case, one would likely have several learner-centered outcomes that would be the focus of different, parallel tracks of study for students. Extending these to larger experiences, and focusing them into smaller experiences, will be discussed later. Although these models do not all have agreed-upon names in the literature, this chapter will refer to them in the following terms:

1. Follow-the-leader: The instructor is not the one who structured the curriculum, but rather some other authority has constructed the organization of the content.
2. Race-to-the-end: The main idea of the curriculum is encountered only after students complete a series of experiences that prepare them for understanding it.
3. Just-in-time-teaching: The experiences are organized hierarchically with the main idea at the top, and a series of smaller experiences build up to it.
4. Mastery teaching: The requirements are spelled out for students to complete in an order and to a level of detail determined primarily by themselves.
5. Dramatic structure: The students experiences are structured according to the principles of a play, with the most important ideas encountered in the middle.

Follow-the-leader. The leader may be the textbook, a previous syllabus, or the way the course you took was constructed, for example. In this approach, these resource materials become the curriculum, similar to Trueit's (2005) mimetic curriculum; its sole purpose is to propagate clones of itself throughout time and achieve an immutable immortality. Many of us have probably defaulted to this model when teaching a new course for the first time. But this model has a serious drawback: it removes the question of how the material is organized one more step away from the students who will be experiencing the content. This makes it difficult for students to make sense of how and why the authors of the curriculum made their decisions. And without this knowledge to scaffold the learning experience, learning is considerably more difficult (Pea, 2004). Often, teacher's guides are provided that have some of this information. But why is it limited to the teacher? Shouldn't students be privy to the overarching goals and structure of the subject, as seen by the author of the textbook? Sometimes authors will spell these goals out in the preface, should students choose to or be forced to read it. As another example of issues with this model, consider what happens when students read the textbook. When I collect my students' notes from their reading, I often find very elaborate and detailed outlines of the material – sometimes taking more space than the material itself! But when I ask them whether they got anything out of it or to use the ideas in other work, they frequently encounter difficulty. I think this is primarily because they copied and outlined material that was organized according to principles that did not resonate with their own ideas and understanding; rather than connect the reading to their own knowledge, they treated it as a block to be memorized. And so, they encountered difficulty because they were attempting to operate at the one level of Bloom's taxonomy (factual recall) which is quite different from the level really needed (conceptual understanding, for example). This difficulty is born out in research on note-taking (c.f. Marzano, Pickering, and Pollock, 2001, pp. 43-44).

Race-to-the-End. In this approach, one develops all the foundational ideas first, then studies the key topic of the course once you have everything you need to derive or understand all the nuances. The early version of one course I helped develop, Mathematical Modeling and Quantitative Analysis, was built on this model (Green and Emerson, 2008a & 2008b). The course was designed to help students understand regression for use in later business courses. As a mathematician, my training suggested that it was first necessary to build up all the mathematical background for the theory of linear regression – algebra, calculus, optimization and so forth – and then derive linear regression formulas. This meant that either the course had a steep list of pre-requisites or that students did not encounter the main idea of the course until the very end, leaving them little time to understand and apply it. In the worst cases, the main idea does not even fully emerge, as too much time is spent on development of the foundational pieces; then the curriculum becomes a collection of seemingly unrelated ideas with no over-arching connections or principles. This is the model typically used for the entire college mathematics curriculum in the United States: a set course of algebra, precalculus, and then calculus. The major problem here is that very few students complete the journey (Gordon, 2008 & Herriott and Dunbar, 2009) and with each piece viewed as being relevant only as preparation for the next step in the process, students are forced to participate in a curriculum that offers them nothing. Without relevance and without the expectation, intent, or belief that they will ever follow the course to the end, the curriculum merely propagates itself, without the majority of the students participating in it effectively. This is based on the Latin root of the word curriculum, *currere*, which leads to implication that a curriculum is a course to be completed. But students seem to perceive such a curriculum as more of an obstacle course to run just for the sake of completing it. This model reinforces that idea.

Just-in-time teaching. Here we teach the minimum set of foundational ideas to reach a topic, then move to a new set of minimal topics. This segmented, modular approach typically creates a feeling of several “mini-courses” each of which is organized as a race. An alternative to this is often employed in more constructivist settings, where a task is set forth and students develop, discover, or research the tools needed to accomplish the task. In this case, the need for certain background ideas or tools is established first by the student in the context of the task rather than by fiat of the instructor. In my first teaching experience, I volunteered to participate in this model for a college algebra course. It involved a lot of jumping around in the primary resource (a textbook) and was a bit disjointed in some sense, but the entire course was still organized around a central theme: problem solving using algebra. And so all the topics were studied as additional tools to help us more efficiently solve particular problems which our previous tools did not help us solve. The “early transcendentals” versions of many college mathematics texts strikes me as the opposite of this approach, since we purposely wait to get to important course concepts (like differentiation) until every conceivable function to which we might want to apply differentiation techniques is understood by the students. The reform calculus text by Hughes-Hallett, et al. (2004) tries to avoid this a little by introducing all the major ideas of calculus in an early chapter of the book to provide structure for the entire sequence. For this model to have coherence the linking structure must be spelled out up front so that students have a scaffold upon which to connect the discrete pieces of the course of study. This is partly the problem with many four-year mathematics majors at typical U.S. colleges. Unlike other fields of study, the introductory courses in mathematics are not survey courses that illustrate the breadth of the mathematics curriculum, revealing a structure that can serve students as a scaffold for the entire program. Instead, each course is a “just-in-time” introduction to its content. If students are lucky, their advisors may help them see the overarching connections or they may have a capstone course that connects it all together. However, after-the-fact connecting may not help, since many of the pieces will fall to the floor without an initial scaffold.

Mastery teaching. In this model, one sets a list of objectives that learners must demonstrate proficiency with and understanding of each topic in a sequence in order to progress to the next topic (Kulik, Kulik, Bangert-Drowns, and Slavin, 1990). Students then progress through the material and check off the objectives at different paces with opportunities for discussion and sharing along the way. I have loosely organized two courses around this approach. The first was an intermediate version of the Mathematical Modeling and Quantitative Analysis course mentioned above. For this course, a colleague and I explicitly listed all of the individual skills and thinking components that were important and tracked, for each student, how well they were demonstrated on each assignment. This proved cumbersome, but it was a necessary step to our final version of the course which follows the dramatic structure discussed below. The other course is a graduate course, Integrating Technology into a Learning Environment, designed for mathematics, science and technology educators at the K-12 level to learn about using technology in the classroom. Since all the students are coming from different backgrounds and teaching in different situations, the course is organized around a large selection of projects. Students select those that are interesting or useful to them, making sure that they complete enough projects in each of the required course areas to earn the points needed to demonstrate their technical proficiency, their theoretical knowledge, and their ability to apply this knowledge to designing learning experiences for students through technology. What may be unclear, though, about this model is what the common classroom experiences are all about and all for, if each student is at a different point in his/her understanding and progress through the material. While one could group the students for activities in such a way that each group has similar mastery (whatever that might actually mean), a teacher would need many versions of the activities. But conversation can still take place, and shared discussion or investigation of new experiences provides a rich environment for ideas to be introduced, reinforced, or reinterpreted. Overall, this seems to be another way to implement the outdated Tyler rationale for a scientific curriculum based on productivity, efficiency, and understanding many separate and discrete elements. Learning for mastery models are also typically thought of as grading or assessment models, rather than curriculum models, but these two components are not independent since one shuold assess in a way that is aligned with how the students are learning. By choosing to use this model for assessment, one is influencing how the curriculum will be structured and laid out, especially with respect to the classroom experiences. Further, one must keep in mind Doll's criticisms of such a curriculum (Doll, 1993, p. 179) regarding the time required and the lack of contingent relations within the content, as they are immutable, remaining unchanged even though the subjects studying them experience growth and change during the learning process.

Dramatic structure. This model uses the basic outline of a five-act play (Dramatic Structure, 2009) with the key content or idea in the middle of the course (climax). At the beginning of the course one introduces the main concepts, background and key ideas (exposition) to set the stage and produce a "skeleton" or scaffold. Note that we introduce here, we do not provide all the details and all the support. Then we develop some of these – the critical ones – in more depth (rising action). After the main idea is encountered in the climax, students explore details and consequences of the key idea (falling action). All of the information is then connected together into a coherent framework (denouement). This focuses the attention on the climax in the middle of the course and provides many opportunities for students to develop deeper understanding of the central idea and its applications. Coherence is a guiding principle of this approach, which also provides guidance for determining student achievement – without understanding the content/concepts of the first stages, the climax is beyond them; those understanding the climax have sufficient understanding to move forward, and those who get more of the details in the subsequent acts are demonstrating deeper levels of understanding. This is a form of scaffolding – build the skeleton up front, get the majority of the flesh on the bones in the middle, then add hair and other details, as one learns to draw a figure. The current version of the MSTI 130 course is now designed around this approach, with regression encountered in the middle of the course. The first half of the course provides some basic data analysis skills and algebra skills in the context of creating models of data. Then the second half explores how to improve the linear regression model by using more than one variable, non-numerical variables, non-linear models and so forth. And through the tool of regression students can then explore the basic ideas of calculus which then can be used to justify the regression process. As in any good drama, the participants should be left with questions rather than providing them with complete closure. The word "closure" – in reference to the completion of a lesson – may be more apt than we think. It indicates a summing up and conclusion to thought on the part of all involved, thus closing future discussion rather than providing an opportunity to expand upon what has transpired. One can view a popular reform calculus text (Hughes-Hallett, et al, 2004) as a version of this: students encounter the main themes of differentiation and integration early in the text. The rest of the text is devoted to examples of these in different applications and techniques for computing them in particular settings.

Comparing the Models

These five models are not intended to encompass all possible ways of structuring a curriculum. They are useful, though, as examples for how one can take content and reframe student experiences by simply changing the organization and reframing the goals of the course. Even creating a truly open-ended curriculum in the sense of Doll (1993) requires a basic starting point. Doll points this out in descriptions of his courses, where the last third of the course brings the open-ended nature of learning into focus; the first two-thirds has a more structured plan, with a given set of readings for all to consider, but not to necessarily come to full agreement on meaning. So we will begin our path to the hyperlinked curriculum by comparing these five models in terms of general problems and benefits and with regard to when students encounter the idea that is most central to the learning experience, as shown in table 1.

Table 1. Comparison of the five curriculum models.

Model	When is the main idea encountered?	Benefits	Problems
Follow the leader	Depends on the original source	Easy to implement from a teaching perspective	Students (and faculty) may never see what the central theme is or worse the faculty have a different theme than the one around which the leader is designed
Race to the end	At the end of the course or sequence of learning experiences	All elements tied together (strong coherence); builds logically	Relevance for the individual pieces may be unclear until the entire sequence is complete
Just in time	Should be up front for scaffolding, but might be implicit	Students do not have to rely on long-term memory as much	Easy to lose main idea in the myriad discrete chunks; non-integrated approach
Mastery	Unclear where it is	Clearly communicates what must be done to "learn"	Difficult decisions need to be made regarding sequencing and effort
Dramatic	Introduced up front, expanded in the middle, reinforced at the end	Clear link to assessment and lots of time for important ideas	Requires significant rethinking of how content is inter-related and what must come first

Looking at the positioning of the main ideas of the course, the five models presented above all seem to be examples of what Smith (2000) calls *syllabus* models of curriculum. That is, the focus appears to be on the content to be transmitted rather than on what is to be learned or how it is to be applied. However, this may not be a bad thing, since cognitive theory tells us that content should be the driving force behind the organization and general approach (Willingham, 2005). On deeper reflection we see that the models are not limited to focus on the content. Rather, they are focused on the way to organize the student's encounters with the content and when the student meets the content that the curriculum considers most essential. Research (Roy, Borin, and Kustra, 2007, p. 26) supports the idea that curriculum reform is more successful when it is focused on *how* students learn (the process and praxis views of curriculum) rather than *what* students learn (the product and syllabus views), so one way to improve the outcomes of curricula is to focus less on particular content than on how student interactions with that content can be arranged to promote better understanding. These five models make it a little more explicit how reorganization can impact learning by looking not just at the content but also at what the students have and what they need or want. Further, "we need to present our lessons in enough *narrative form* to encourage our students to explore with us the possibilities that can be generated from dialogue with the text" (p.169, emphasis added). In this last, consider that the word "lessons" can be replaced with "course" or "degree program" and the word "text" can be replaced with almost anything that is outside the student and intended to support learning, be it a discussion, an activity, an experience, or an object.

An important dimension of comparison in the models is the degree to which the very structure of the curriculum supports learning through scaffolding. In several of the models, the organization makes scaffolding difficult, but it is essential for learning in that it allows instructors to

> …[present] new material in the form of an overview, which shows how the new subject area relates to other similar subjects, by pointing out differences and similarities in relation to these topics and by introducing basic theories and new concepts in the field of study. Such an overview of a new subject area should help increase the possibilities of the student being able to see the connections that are obvious to someone who already has an overview, and to open the student's eyes to familiar elements in the new subject area which he or she can latch onto and in this way increase the likelihood that the students can join the communication. (Rasmussen, 2005, pp. 228-9)

The models can be compared in several other dimensions. What is the type of the central theme the curriculum? Is it a fact, a concept, a strategy, a style of thinking, a process? When do students encounter the central theme? How embedded are Doll's four R's of Richness, Recursion, Relations, and Rigor (Doll, 1993, p. 176)? To what degree is the curriculum relevant to students? Where is the instructional burden (preparing lectures, designing activities, providing guidance and feedback)? What assessment supports it most effectively? How easy is it to promote vertical alignment across developmental levels? What about alignment between assessment and goals and activities?

Doll (1993) says "the learner in the curriculum course needs to know the material well enough to be able *both* to solve, interpret, analyze, and perform the material presented *and* to play with that material in imaginative and quirky manners" (p.164). This suggests that the dramatic structure, a type of narrative form, is more suited to curriculum planning, as the falling action and denouement provide time to play, while the rising action and climax provide facility with the idea. Other structures suffer from difficulty to remediate students: if they do not encounter the most important idea or experience until the end, and they cannot fully demonstrate their ability to use and understand it, what opportunity is there for the student to continue deepening his or her understanding? What is needed is the recursive interplay of ideas that can be achieved in several of the other models.

For example, in applying our COGS system of grading (Green & Emerson, 2007) to Mathematical Modeling and Quantitative Analysis, the curriculum has a single main content goal (regression) that is placed in the middle of the course following the dramatic model. But all course assignments are constantly focused on three main goals (developing mechanics and technical skills, applying and interpreting mathematical models, and effectively communicating in a professional manner), similar to the way themes run through a play. One could also view this design as a coherent process-oriented curriculum, focused on procedural knowledge, rather than a fact-focused curriculum focused on declarative knowledge.

UNCOVERING THE HYPERLINKED CURRICULUM

Unfortunately, the five models compared above are misleading. For one thing, not all content can be organized easily according to each of the five models. For another, a graphic representation of each would suggest that the ideas and content of the learning experience form a linear sequence or a simple chain which students can learn step-by-step. But knowledge and understanding cannot easily be represented by such a linear, outline-type structure. Knowledge is much richer and more interconnected than a linear graphic can represent. This is one reason for the success many teachers find when using concept mapping and mind mapping. Knowledge is about more than facts; it also includes relationships among those facts. And the technology of the World Wide Web has given us a powerful metaphor for knowledge: it is a hyperlinked structure of objects with explicit relationships linking those objects together. After looking at these options, we now look past the specific examples of curriculum organization to what lies beneath them. In doing so, we will uncover the way to the hyperlinked curriculum.

This curriculum is similar to the "fractal curriculum" Fowler (1996) envisions. It is ever-branching and ever-deepening, always changing as a result of the students and their interaction with the curriculum. A student's learning is then never complete, explicitly demonstrating a need for the elusive quality of being a lifelong learner. The hyperlinked curriculum is not a dramatically new idea. We have always had a complex, hyperlinked structure of knowledge underneath our teaching, although we have not always made it explicit, and sometimes we have not even participated in its construction. Regardless of the linear ordering of our experiences in time, information has dimensionality, and it is different for different formats or presentations.

1. An oration is essentially linear and unidirectional, but a good orator will move into a second dimension by building recursive reminders of earlier concepts.
2. A basic book is two dimensional with the reader controlling the movement forward and back and able to jump and explore connections; but the initial design, structure and creation of the material is still controlled by the author. The jumps can be supported with cross references and citations to other material.

3. A hyperlinked resource is three dimensional with all connections made explicit; the viewer is responsible for reading, choosing a path, following the links and constructing meaning.

In mathematics this type of three-dimensional structure is an example of a graph. Such a structure is composed of nodes of ideas and facts that are connected together with edges describing the relationships. Not all nodes are connected to all other nodes; not all nodes even need to be connected to the graph at all, leading to the possibility of several disjoint structures, each graphs in their own right. Graphs have been used to study and solve many problems beginning with the Koningsberg bridge puzzle that Euler used to develop the basic theory of graphs and extending in the present day to program efficient algorithms for soldering integrated circuits.

In order to understand what exactly the knowledge graph is, we need to identify the nodes and the edges connecting them. The edges are a little more straightforward to understand, at first glance. Two nodes are connected by an edge if they have something in common. But the keyword in that definition is "something." The two nodes might represent experiences or parts of experiences that occurred at the same time for the learner. They might indicate a hierarchy, so that one node is needed in the definition of the other node (it would be difficult, I think, to make sense of electrons and protons if one does not already have the idea that matter is made up of many atoms.) The relationship might indicate that one node is an example of a more general idea contained in another node. There are a great many relationships that could be possible. Just to get a hint of the complexity, try looking up the word "energy" on the Visuwords website (http://www.visuwords.com) and consider all the links and relationships present for this fairly objective, factual knowledge.

These nodes and edges can be represented visually by using circles for nodes and lines for the edges. If drawn out on a piece of paper, this means that many of the relationships will require that some edges cross. In order to avoid this and to make sure that all the relationships are distinct and clearly shown, the structure must be represented three-dimensionally. This three-dimensional structure is, in fact, one of the main reasons for so many different approaches to curriculum. Compare several textbooks on the same subject matter, for example. They may have the same ideas, but probably have quite different organizations to them. This is because each author has taken their unique network of ideas, a three-dimensional structure, and projected it into an ordered outline. This projection is very much like a geometric projection, similar to shining a flashlight on an object and observing the shadow. Imagine, as in figure 1, that you have a network of ideas connected together and that we shine a flashlight onto it from above. This projects a shadow of each idea and the links between them that orders the ideas in a particular linear sequence. Now take the same network of ideas and shine the flashlight from the left; a new linear order of the ideas is projected, as shown in figure 2. Depending upon the direction of the light, a different shadow – or projection – is seen, one that captures a different order and different relationships within the content. These figures show a simplified example of this, projecting a two-dimensional network onto a one-dimensional shadow, reducing the dimensionality by one. And even in this simplified reduction we see vastly different projections. Imagine how much more varied the real task is: project the three-dimensional structure into a single dimension. There is, in general, no unique way to do this, except for very simple networks. Thus, the choices of projection, which are usually in the hands of the teachers, hide many aspects of the knowledge network underlying the course or program. This is what has been done in the models described above; in each case, someone has projected the network of course ideas into a path that places the main idea somewhere in a linear sequence of events.

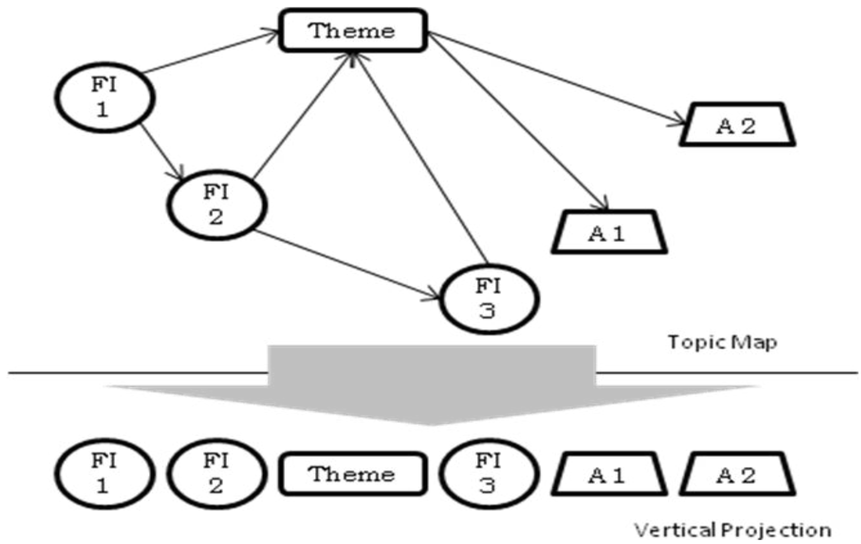

Figure 1. A vertical projection of ideas from a simplified two-dimensional network into a linear sequence (FI = Foundational Idea, A = Application).

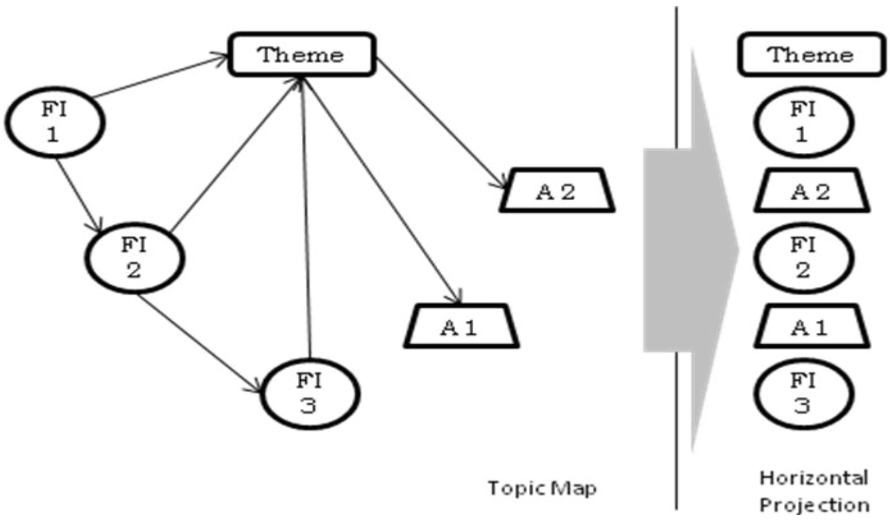

Figure 2. A horizontal projection of the same network in figure 1, showing how the linear sequence changes if the projection is chosen differently (FI = Foundational Idea, A = Application).

To make curriculum choices even harder, one must recognize another fact from mathematics that relates to the hyperlinked curriculum, if one is attempting to construct a projection that is “the best way to organize a course of study.” Aside from the choice of which projection to choose, there are many equivalent underlying graphs that look very different even before they are projected. Some of these simply involve rearranging or relabeling the components of the graph. Others involve more subtle changes. Finding the best option becomes a truly daunting task if the teacher seeks to maintain control over the flow of information. But the hyperlinked curriculum is not about the teacher controlling the flow of information; it is about the teacher participating with the students in a conversation to help them develop their own knowledge structures.

To build a curriculum that does justice to the complexity of knowledge, students need the opportunity to see this structure, to build this structure and to grow their own version of it. They can include their personal knowledge, which is a similar network "rooted in a web of associations that is present in the social phenomenon of language" (Davis and Upitis, 2004, p. 120). Each participant in the classroom has such a personal network of ideas into which each learning experience must be fit. Additionally, there are networks of ideas outside the content that impact the classroom, like those implicit in the district and state standards. There are pieces of the structure that are not even ideas, but are simply components of the individual's situation and attitudes. There are political pressures and social constraints. The hyperlinked curriculum brings all of these together in natural way, allowing them to interact, so that a whole emerges that is much more than the sum of the parts.

This extensive network of ideas and their projection into a sequence of experiences certainly seems to meet the postmodern curriculum theorists' requirements of richness, recursion, relations and rigor (Doll, 1993, p. 176). Certainly the knowledge developed will be richer, as the student adds connections and follows them. It is a structure of curriculum that is inherently relational. Rigor is partly self-imposed (students will need to find satisfactory answers to their questions as well as adequate solutions to problems they encounter) and partly external through the teacher's expectations that students make use of their knowledge. And recursion is built in through the reflective aspect of the curriculum by which a student selects nodes to explore and modifies his or her existing knowledge structure.

Teachers in the hyperlinked curriculum take on a new role: We are responsible less for choosing the perfect projection and more for gathering the resources and explicitly revealing some of the connections so that students can navigate the material and construct their own meaning. This "fractal curriculum" (Fowler, 1996) is a very different view of curriculum. Teachers must still work together to determine appropriate learning goals and make it clear to students what our expectations are. But this model is adaptable to all modes of learning, including online teaching and learning, and it is inherently dynamic, so that the same course will never exist twice. It is dangerous: students can easily get lost as they wander through the maze (hence self-regulation and monitoring must be encouraged) and administrators may struggle to support such an environment in the face of parent and district expectations regarding common experiences, mandated testing, and the like. Much of teachers' work would then occur outside of the students' direct experience. Teacher interactions with students would then focus more on locating resources, providing guidance, offering feedback, constructing scaffolding, and questioning ideas, than on presenting information.

This is not to say that teachers should allow an all-for-themselves approach to learning or that all paths through the space of ideas connected to the course are equally useful and valuable. Consider the Project 2061 strands and standards. These clearly form a connected web of ideas related to scientific understanding, but some chunks are more fundamental and critical than others. Kuhn (2008) offers an approach that can be easily adapted to other networks of knowledge through the tools of the mathematical area of graph theory. Graph theory deals with structures exactly like the three-dimensional knowledge spaces of the hyperlinked curriculum, and has tools available for the identification of critical paths, critical components, and connected components of material. These tools may suggest ways to group ideas together, providing fodder for designing activities and experiences to support learning. These tools can identify critical pieces that cannot be lost if a student is to progress effectively in the larger curriculum. And these tools can be automated, so that not every teacher needs to become a mathematician specializing in graph theory. But every teacher must still exercise his or her pedagogical content knowledge (PCK) in order to connect the current learners to the curriculum.

Since all of a student's knowledge and experiences could be placed into a single, giant map, we will occasionally refer to this as "the hyperlinked curriculum." However, as a teacher, one is most often concerned with the piece(s) of that map most closely connected to your current classroom. This will be referred to as "a hyperlinked curriculum" rather than the more cumbersome "a specific portion of the hyperlinked curriculum." We summarize our description of the hyperlinked curriculum with the following description. Students start with an introductory experience that could be anything that is appropriately chosen by the teacher to engage the students in the central theme of the course. It could be a problem to solve, task to complete, or any other activity which can be used as an entry to the rest of the course's content. As students engage in the activity, they begin exploring a simplified map of content connected to the course. This simplified map provides the scaffolding needed for students to begin framing further questions and planning their investigations. Then they are given time to explore with support from teachers and each other. Along the way, they reflect, share, compare, and extend their ideas, seeking new experiences to connect with. Throughout it all, the students move from node to node within the complex map of knowledge behind the course, constructing a map of knowledge that represents their own understanding. In the end, they synthesize this understanding and learning in some way that demonstrates their achievement of a mix of personal and programmatic goals.

EXPLORING THE HYPERLINKED CURRICULUM

While many theorists are asking interesting questions about curriculum design, Wang (2005) asks the question that is most relevant to the hyperlinked curriculum. He contrasts the curriculum with a Chinese garden's fractal structure, and questions (p. 303) where we should place the key to understanding the entire garden. He concludes that learning would best be served if this were not necessarily at the end of a long, linear chain of development, and asks how one can construct a curriculum allowing multiple branches and paths, a nonlinear curriculum, like the hyperlinked, web-based structure I am advocating. As in the Chinese garden, one views the curriculum in different ways at different times based on different sequences of experience. Reflecting the dichotomy of whole versus part, Wang is really talking about choosing a direction for projecting the curriculum into a linear experience. He makes it clear that in the Chinese garden, one starts by looking at the parts, in some order, then seeing the whole, which would definitely influence the whole that one perceives.

We must be careful not to oversimplify and lose the richness and complexity of real knowledge. Scholars like Davis (2005) reject the standard concept map view of the curriculum (p. 130) based on the idea that the nodes in the graph are concepts or facts. It is more useful, I think, to construct our knowledge maps not just using terms and facts and procedures, but also learning goals, student motivations, relationships, particular social, cultural and political aspects of the learning environment of which the students are aware. Everything should be brought in, not just the explicitly accepted objects of the subject matter. Each item in the concept map could also appear in several ways, each reflecting a different way of thinking about it. These maps would be richer than traditional models of knowledge and would be more authentic representations of student knowledge space. They would be directly more hyperlinked. Thus, the nodes of the graph are not strictly from the “domains of knowledge” in Bloom’s taxonomy (facts, concepts, and procedures.) Instead, these elements could themselves be relationships and relational constructs that would then evolve over time, possibly expanding to become subgraphs of their own, thereby building in a recursive and fractal component.

Clearly we have a problem now. Just visualizing the connections and their development and growth over time would be difficult. To make it even more interesting though, consider other types of graphs from mathematics. Perhaps it is more useful to represent knowledge not just as a graph, but as a directed graph, where each edge has a direction, possibly indicating a hierarchy of nodes. Or maybe the curriculum is a weighted graph, where the weights indicate the “cognitive cost” of going from one idea to the next (i.e. application would have a higher cost than recall.) Regardless, one of the major barriers to the hyperlinked curriculum is the need for an efficient, easy-to-use tool for presenting and modifying such three-dimensional maps. But there currently exist many software packages that are excellent beginnings. Some of these will be mentioned later.

The richness of the hyperlinked curriculum is even more evident when we recognize that the underlying network of ideas is really just that: a network, not a graph. Graphs, in mathematics, are static. Networks are growing, dynamic structures. Connections are broken and re-formed, new nodes appear, and old nodes vanish. Such mathematical models occur in nearly every discipline, ranging from human-made examples like the power grid to the evolution of cellular functions. This dynamism reflects the nature of metacognition. In Bloom’s revised taxonomy (Anderson and Krathwohl, 2001) metacognition is a separate knowledge domain, but it seems that this layer is essential for modifying the other layers and types of knowledge through monitoring and so forth. And this type of knowledge is most active when monitoring and evaluating other processes. Without tasks at the upper level of the cognitive domain, like tasks involving creation of new knowledge, it is doubtful if students are really even learning. The hyperlinked curriculum builds this directly into the student’s experiences. Thus, reflection and constant self-monitoring, aided by teachers and other students, are essential components of the hyperlinked curriculum.

Network theory also suggests that the aphorism “the rich get richer” is born out in practice in many existing networks of the so-called “small world” type (Watts, 2003) which is likely to represent learning and knowledge. For example, people with many acquaintances are more likely to make new acquaintances. If we think about the hyperlinked curriculum this way, and we think about being able to more clearly see and follow the network of ideas our students hold, we may learn more about the very nature of knowing and learning. In learning, one might posit that ideas having more connections for a student are more likely to be active when they encounter something new. Thus, these ideas are more likely to get connected to the new idea, even if some other concept or experience in the student’s past is more closely related in some objective or external sense. The student might then insist on particular interpretations of things (sometimes called misconceptions) in spite of simultaneously possessing other knowledge that contradicts.

Ultimately, the underlying structure shows us uniformity in the five models presented earlier. The main difference is on which projection is selected. But Doll and many others argue that we need to go further. In the follow-the-leader model, someone else constructed the graph and projected it into the resources. In the other models, it is the teacher who selects the projection that highlights the main idea most effectively for the students and the content. But a truly open curriculum would require that the students explore the graph of connections on their own, making their own meanings and wandering through the space of ideas. This would require some easy way to visualize the three-dimensional structure, to rotate it and manipulate it and project it in different ways until we find an interesting or useful way of perceiving it. One would also need to view the curriculum as a living structure and be able to mark pieces that have been explored at different levels (introduction, deep exploration, etc.)

We now see that precursors of the hyperlinked curriculum are really underneath all curriculum models and what really changes from one set of curriculum models to the next are the roles of the participants, separating all theories of curriculum into three "generations." First generation curricula are designed to reproduce the old examples faithfully, ad infinitum (and possibly ad nauseum). Using second generation curriculum models involves searching for the best projection of the teacher's knowledge graph into a linear temporal dimension. But the graph exists in the teacher's resources only and the students usually do not get to add to it, modify it, or even see it. Third generation curriculum models, ones that are just starting to emerge, open up the nature of learning so that students construct, navigate, and modify the graph to develop their own understanding.

BUILDING A HYPERLINKED CURRICULUM

So now we find ourselves with a complex knowledge structure that needs to be organized into coherent experiences to help students learn. We also need to be careful in our use of the metaphor. One could easily argue that finding the "right projection" is a return to Tyler's curriculum models, that of the production line. Instead, we view the projection concept as a metaphor and recognize that each different projection will result in a different ordering of the curriculum, constructing different hierarchies of importance among the experiences and ideas, and these can lead to different understandings. Some of these will be good (in the sense of being useful); others will be bad.

To give an example of the bad, during one semester of the Mathematical Modeling and Quantitative Analysis course, we used different height stacks of blocks to explore the concept of average. Later in the semester, we made use of histograms in studying the spread of data, and we wanted the students to connect the ideas. Specifically, we wanted students to develop a method for estimating the average (mean) of a distribution from looking at the histogram. After reading several student approaches that seemed totally unrelated to the concept, we finally realized that a visual similarity between the stacks of blocks and the histogram was being conflated by the students, so that they were averaging the heights of the histogram bars, rather than the underlying data that the histograms represented. Thus, we reordered the topics so that the ideas could be more easily separated and allow for time spent discussing the differences.

Moreover, these models are not isolated from one another. Since we have several levels at which the curriculum operates – the program, the course, the unit and the lesson – we can embed these models within each other or run them in parallel. To avoid problems of redundancy or gaps in the curriculum, though, we must make use of the hyperlinked curriculum map. Thus, we can use a dramatic approach for a single, smaller unit of study, while allowing for connections to other units and ideas to arise naturally.

We must also bear in mind that the content map is continually being reinvented, re-experienced and re-imagined by each of the participants. Thus, possibly the most useful tool for studying what students know and understand is conversation and discussion related to individually created mind maps and concept maps. We can also compare these maps to the maps of the "experts." In doing so, we are not comparing in order to point out weaknesses in their learning (this is the view of curriculum as what they do not understand yet) but to see where their notions come from and look for opportunities to construct new meanings from new experiences, one of which is the comparative process itself.

Ultimately, though, does the mind form, break, and reform these connections one-at-a-time or in parallel? At what time scales are these connections made and remade? Are the time scales all the same? The notion that students all learn different things – different from each other, different from the "teacher's notions", different from expert notions – is not new. What is new is that educators may be more conscious of this now through the collection of data (formative assessment) than at any time in the history of education. As we discover more and more that our students have different ideas, understandings, needs, wants, and experiences *even of the same events*, one rational reaction would be a return to the past: remove as many of these variables as possible by providing identical experiences (i.e., a lecture). Certainly some material can be "transmitted" more effectively in a lecture, but for students to "receive it" the organization and thinking structure that is behind the logic of the lecture needs to be made explicit. Even then, evidence suggests limited success.

Throughout the entire curriculum process, we find that teachers are then faced with quite a few places where decisions must be made and where professional judgment must be exercised. Some of these curriculum decisions are obvious: What text and other resources should students have access to? What assignments, activities and projects should students focus on? In what order should the topics and experiences be generally organized? In making these decisions, the content and the context are important. Possibly of more importance is comfort: What strategies and tools is the instructor most comfortable in managing within the classroom boundaries? This is not to say that only tools with which one has comfort should be used, by any means, but it should be a consideration in balancing time and effort.

PCK is one source of information for making instructional and curricular decisions, but in this "assess first, ask real questions later" era, our administrators demand more support and evidence for our decisions. Certainly one could turn to scientific investigations of curriculum and learning, but care must be taken. Many (c.f. St. Julien, 2005 and Flinders, 2003), reject the reductive, analytic mode for educational research, claiming it provides no insight into learning. For one thing, there are simply too many cases for us to either (a) understand all the parts or (b) have a transferable result. However, this mode of investigation is useful for certain situations where the number of variables is small, manageable and controllable (i.e. physics). These suspicions have led many educational theorists to reject most quantitative studies, due to the falseness of the underlying assumptions that "the elements of analysis are both separate and stable" (St. Julien, 2005, p. 109). These assumptions are completely counter to the entire foundation of a hyperlinked curriculum.

In order for us to rely on such reductive modes for educational decision making, one would need detailed models which accurately (or at least statistically) replicate classroom behavior and student learning as the environment and initial structure are varied. Such models would be incredibly useful; teachers could generate data representing a class similar to theirs and then feed in a series of instructor decisions and supporting resources. The results of the simulation could then be used to tweak the decisions, iterating until a desired level of result is achieved. Currently, though, we do not even have weather-quality simulations and models for learning. Furthermore, these cause-and-effect models would need to be unduly complicated to account for every possible connection and variable. And while slight changes in the situation (did Johnny eat his breakfast this morning? Was he running late?) seem irrelevant, if educational systems are indeed chaotic, as the nonlinear sciences suggest (Doll, 1993) then the butterfly effect would allow such insignificant details to have tremendous, qualitative impact on the curriculum. Therefore, it seems we need to abandon this approach entirely and instead build more relational models that do not attempt to make predictions, but instead seek to generate ideas. Given the number of variables at all levels and the hidden nature of many of the learning processes and interactions involved, it seems that we will never have useful input-output computer simulations for curriculum and instruction. Fortunately, we do have non-computer-based simulations; they're called classrooms. Unfortunately, we cannot easily run multiple experiments on them and iterate until we are successful.

Instead of this "find the best method by experiment or simulation" approach then, we should apply what knowledge we do have to construct a learner-centered curriculum where the curriculum

- Features tasks that stimulate students' varied interests
- Organizes content and activities around themes that are meaningful to students
- Has explicit built-in opportunities for all students to engage their higher-order thinking and self-regulated learning skills
- Includes activities that help students understand and develop their own perspectives
- Allows learning activities that are global, interdisciplinary, and integrated
- Encourages challenging learning activities, even if students have difficulty
- Features activities that encourage students to work collaboratively with other students (McREL, 1994, as stated in McCombs and Whisler, 1997, p. 66, Exhibit 3.1)

The hyperlinked curriculum inherently meets these expectations. Students are completing tasks and following individual paths through the curriculum map as their own interests are engaged. The themes and relevance are established by negotiation among all participants, and higher-order thinking skills are needed to even begin the process. All learners are exploring the material in different ways, so individual perspectives are guaranteed to develop; these can then be shared and contrasted to develop even more connections and perspectives, thereby building in collaboration. Possibly the hardest conditions to meet are the requirements for integration and challenging activities. These are more in the instructor's control, but students should be given the opportunity to design their own assessments and demonstrations of learning in the presence of clear guidelines and expectations for the level of detail and thought that should be present.

We now see that a well-build hyperlinked curriculum not only meets the requirements of Doll's four R's, it is also strongly builds in a fifth R, Relevance. Further, the hyperlinked curriculum has a strong sense of Coherence, drawn from two different directions. The first is through the "sense of purpose, unity, relevance, and pertinence" (Beane, 1995, p. 4) that instructors give through the activities and projects they select for students s starting points in the learning process. The second is an emergent sense of coherence when students construct their three-dimensional maps of knowledge. The coherence from this is based on connecting everything together through their motivations and interests. Thus, another criterion for comparing curricula is the degree of coherence in the proposed curriculum, or, more accurately, how much coherence can emerge from the curriculum, rather than simply consider the explicit coherence present. Herein lies another challenge for teaching in the hyperlinked curriculum: probing students and pointing them in new directions which allow them to develop a sense of coherence. This requires that the students must include themselves (their interests, strengths, etc.) in their maps; the maps cannot be independent of the participants. Without this individualizing aspect, we have not truly embraced the hyperlinked curriculum. Perhaps the most useful notion of coherence that can emerge comes from shifting the focus from the content to the application of the content: a view of curriculum as *praxis* (Smith, 2000) where the curriculum derives meaning from examples of real world problem solving through critical issues of relevance to the student and the larger public. This is coherence through application to the real world.

Determining a model for coherence, even among fairly similar content in science, can be challenging. Ahlgren and Kesidou (1995) contrast three approaches to grouping topics for coherence. One could simply group all the topics from a single map that occur at the same grade level (developmental coherence, p. 50). However, the integrating idea may not appear for quite some time, giving coherence from the structural perspective, but not from the learner-perspective. A second model is to connect all the strands from several maps that interact at a single grade level (cross-connection coherence, p. 51). This strategy runs afoul of the difficulty inherent in constructing or finding activities which integrate these concepts. A third approach, the one taken by the Project 2061 teams, is context-based coherence (p. 51) wherein the strands and goals do not necessarily connect except through the activity being investigated. Thus, the activity provides the connecting piece. They then proceed to describe four possible purposes that curriculum blocks could be built around: description and explanation; design; issues; and inquiry. So long as each block maintains this "coherence of purpose" (p. 52) it remains comprehensible to students.

Lest we focus too much on the silver lining of the hyperlinked curriculum, we should also pay attention to the cloud itself. We face a great many constraints on any curriculum development project. These range from the time needed to construct the curriculum blocks and assemble their resources; the lack of a common, set pace for all students; political pressures to prove this is appropriate and that our students will meet external expectations; and other issues too numerous to discuss here. In larger programs, we must worry about faculty expertise, fitting transfer students into the program, and offering service courses to meet the needs of multiple constituencies. Individual courses would have to seriously rethink their pre-requisites and exit expectations for the sequence. Social issues also dominate curriculum design processes: other faculty members are involved, bringing different perspectives to the process and other programs are impacted when one program makes changes. Smitherman (2005) uses the term “bounded infinity” to refer to a curriculum like this: It is fully bounded and constrained by outside factors but, like a fractal, can still allow an infinite variety of learning experiences to occur.

Add to these concerns and constraints the realistic situation in which a program curriculum involves several major goals that may be running in parallel. Thus, students would be exploring multiple goals simultaneously in parallel experiences. This is a serious issue with Project 2061, and seems to have generated a multitude of approaches for dealing with it (Ahlgren and Kesidou, 1995). Given all of these constraints, it seems that Fowler’s preview (1996) of the hyperlinked curriculum is too far removed from where we currently are. His picture of curriculum as a series of web-based, interconnected platforms with tools and resources and multi-user interfaces is an intriguing version of a hyperlinked curriculum, but the effort to achieve this would require both a complete rethinking of the content we teach and the themes around which it is organized. More importantly, it would require a significant retooling of the entire teacher certification process, leading to major problems of what we do with the teachers we currently have and the students currently in the race. Some more intermediate step is needed unless we plan to abandon whole generations of learners on our way to the hyperlinked curriculum.

At the same time, Fowler does not go far enough; he envisions what themes could be used to organize the mathematics curriculum. And while this is needed desperately at all levels, given the age of the current post-secondary curriculum model and the linear flow of topics with calculus at the pinnacle of the secondary school curriculum, he fails to consider rethinking global themes to reorganize all of education. In the long term, our goal should focus on constructing a single, coherent, truly integrated hyperlinked curriculum, at least for the P-12 setting. One example of this latter is provided by former U.S. Commissioner of Education Ernest Boyer in his eight themes for education: the life cycle, language, the arts, time and space, groups and institutions, work, the natural world, and the search for meaning (Boyer, 1995). A curriculum built on exploring these themes over a number of years would delve into every aspect of human knowledge and interest.

Between the extremes of disciplinary revision and whole curriculum, falls the “supradisciplinary curriculum” of Brady (1995) which is built on answering the traditional 5W’s of a reporter: who did what, when, where and why (p. 28). Brady expands these questions into a framework for considering all experiences as composed of actors, actions, thoughts, time and environment, and then proceeds to illustrate how many other ideas naturally fit into this framework since it “encompasses and organizes everything we know” (p. 29). This would require that we add a sixth question, how it was done, to encompass all the possible aspects, but is a more modest suggestion than Boyer, while still serving as an example of a way to organize a hyperlinked curriculum through a coherence of method..

As a first step, however, we can envision the more limited approach of reforming specific discipline-based curricula at the post-secondary level. In this light, what would a hyperlinked curriculum for mathematics look like? Most current U.S. college mathematics programs look similar: there is a foundational sequence – often calculus-driven – of computational mathematics which transitions to more abstract mathematics through discrete mathematics and linear algebra. The programs generally finish with a sequence of proof-based courses like real analysis or abstract algebra, and might even have room for electives or some tracks in applied mathematics or statistics. The truly hyperlinked mathematics curriculum would indeed look different. Rather than define courses by their specialty content and set up a rigid flow from one course to the next with extensive chains of pre-requisites, one could create three strands of courses. One strand would focus on computational mathematics, allowing students to explore topics as needed and as interested, ranging from calculus to matrix operations to differential and difference equations, but with applications driving the individual course offerings, rather than particular, prescribed mathematical content. The second strand, which might not start until the students have developed some general computational fluency and familiarity with terminology, would involve abstraction and proof, focusing on rigorous mathematical structures, axiom systems, and logic. The third strand would start later, separating out from the first two, where the ideas and habits of mind would be established. In this strand, students would focus on mathematical research. The courses in each strand would not have content-driven endpoints and learning goals. Instead, each would have a large body of possible directions, and students would explore them as they found a need or interest in the context of the current problem or application or experience. These applications would serve to provide coherence, and the resources available would range from traditional textbooks to online materials, sophisticated computer algebra systems to specialized software packages, and from hands-on experiments to data-gathering experiences. In particular, I have in mind courses similar to the "Applied Mathematics Lab" course at the University of Arizona (http://appliedmath.arizona.edu/research/labs/aml). Instructors would collaborate in order to help students transition between courses within a strand and navigate from strand to strand. Many other possible strands (such as one on representation or numerical analysis) could be generated, but these three provide a glimpse of the possibilities.

LEARNING IN THE HYPERLINKED CURRICULUM

So now we have constructed a curriculum designed for students to explore and develop their own ideas and connections. How exactly will they do this? In moving to the hyperlinked curriculum, students will have to completely change their role in the classroom. In didactic classrooms, students are passive receivers of information, memorizing and repeating information without necessarily making it their own or making sense of it. In constructivist classrooms, students are involved actively in learning, solving problems and reflecting on the process in order to deepen the connections. But in these two cases, the basic outline of the curriculum, the decisions about what is important and the order in which it should be encountered, is determined not by the learners but by external forces.

Past curriculum changes in higher education curriculum, ostensibly designed to meet the challenges of 21st century living and citizenship, have focused on either changing the content (what is to be learned) or modularization by repackaging the content for "just in time learning" (Cleveland-Innes and Emes, 2005, pp. 88-89). This leaves out the development of lifelong learning, preventing institutions from developing graduates who can "learn their way through life". Instead of the menu approach to course selection and curriculum planning, we should be developing opportunities for students to participate in curriculum decisions and construction. This would avoid the dichotomy between the curriculum offered and curriculum taken. This interactive participation harkens back to the New Sciences curriculum of Doll

(2005). Unfortunately, we have made, at best, incremental changes to curriculum because we are focused on a curriculum paradigm rather than a learning paradigm. Ultimately, this will lead to a curriculum that is learning focused, one where students learn about learning and participate in shaping the curriculum to meet their needs as learners (Cleveland-Innes and Emes, 2005, p. 96).

The hyperlinked curriculum is a learner-directed curriculum, not just a learner-centered curriculum or learner-centered teaching, as most reform can be described (McCombs and Whisler, 1997). The hyperlinked curriculum itself will guide this decision-making process. With it, students can see the links that someone else has made explicit, select those of interest and importance, and investigate them further. Even more exciting, the links that are missing or incomplete can be investigated by the student, leading to an expanded view of the content for all concerned, exploring the "web of curriculum content" (p. 98). Students can add, delete, reform, and modify existing links and nodes. In summary, embracing the hyperlinked curriculum will require many of the same expectations as the learner-centered curriculum requires (McCombs and Whisler, 1997):

1. Explicit and accessible documentation of required outcomes for content mastery and skills development (p. 97)
2. Explicit and continuous reference to documented evidence of beneficial student experiences, personal development, and learning processes (p. 98)
3. Choices will be available regarding pathways to master skills and knowledge, with reference to decision-making, regarding appropriate learning opportunities (p. 99)
4. Curriculum delivery will be flexible and offer choices that result in blended learning (p. 100)
5. Clarity of role expectations and required behaviors as life-long learners (p. 101)
6. Role adjustment for faculty – ensuring a well-developed position exists as content expert in combination with support for learner development as a deep, independent and self-managed learner (p. 101)

The hyperlinked curriculum is a curriculum designed on the idea that curriculum cannot exist independent of students. For this to happen, students must completely change their expectations of classrooms and teaching. The important skills are no longer related to memorizing and repeating information. Students must learn the habit of constant reflection, develop their ability to collaborate with a wide range of different learners, focus on skills for comparing and evaluating ideas, and hone their skills in locating and evaluating resources.

Constant reflection is needed so that students can make sense of their experiences. Without it, the experiences threaten to be disjoint, both from each other and from student interests and needs. Through reflection, though, students can integrate their experiences and relate them to the common themes that have been used to scaffold the larger learning experience. This process of reflection will be vital to helping students select their way through the curriculum, choosing paths to follow and directions to explore. Since students will not be passively receiving information, they will need to learn how to define and refine questions, and locate and evaluate resources, and design investigations that point toward pieces of the answers to those questions. And through it all, as students encounter new ideas and connect them together, they will be engaged in comparing ideas and evaluating them in order to push past the surface to make deeper connections, continuously evaluating their solutions to problems for efficiency, accuracy and applicability.

Students will not be able to effectively participate in this curriculum in isolation. Communication with others – students, faculty, family, community members, and experts – is already an essential skill. As technology allows and encourages more collaboration through blogs, wikis, and other tools, students will be better prepared to use these tools to share ideas and build new understandings (Maloney, 2007). This is occurring naturally now, although in the informal world of the internet. Recognizing this and building on it, the hyperlinked curriculum offers new opportunities to motivate students, by reaching them inside their world and validating that world by connecting it to past human experience and scientific understanding. But they will need to develop a broader range of ways to collaborate, under guidance from teachers to work effectively toward the accomplishment of their goals.

These skills are all part of many existing college core programs. What we must do, though, is work to help students develop them earlier in the educational process, so that they can participate in their learning and draw upon these as their fundamental skill set. As they learn about their own learning and how to effectively manage the learning environment in collaboration, they can explore mathematics, science, social studies, and every other area, but in a natural way, unconstrained by the artificial boundaries of traditional academic disciplines. They will learn to explore problems naturally, pulling resources from wherever is appropriate. Thus, students must also undergo a change in attitude, looking for opportunities to learn and resources to help, rather than waiting for them to be presented. These skills will all move from supplementary skills that are add-ons to current programs of study into the central focus of the curriculum.

An important part of this change in attitude will involve growth in critical thinking. Not only will students need to develop deeper skills, but they will also need to progress more rapidly through the levels of critical thinking. While it may seem daunting and difficult for students to move from strictly looking for factual information, to seeing the variety of ways a problem or question can be answered, to playing teachers' games (Nelson, 1999) and on to making their own judgments and evaluations of information and relationships, we must remember that students participating in a hyperlinked curriculum will be constantly reflecting and collaborating. Their ideas will be juxtaposed with others more frequently and more explicitly than in previous learning experiences, so this progression through stages of thought will be a natural progression that teachers can be aware of and encourage. A natural outcome of this curriculum, then, will be more critically aware students.

Finally, students will need significant competence in information management and representation, most probably in the form of computer software for searching and managing information and for creating, updating and manipulating their individual knowledge structures. Current programs such as Inspiration (http://www.inspiration.com/), Topicscape (http://www.3d-scape.com) and Mindvisualizer (http://www.innovationgear.com/) are starting to integrate the tools necessary to support this sort of learning and thinking experience. Comfort with these tools and with tools for communication and collaboration will be critical for students in the hyperlinked curriculum. All of this means that students will also require access to these resources. Since much of this information will be accessed and modified frequently, some sort of portable computing device will probably be the most efficient way for students to interact with their information and collaborators. These new expectations on students encompass all five of the digital literacy subskills defined by Eshet-Alkalai (2004):

photo-visual literacy, reproduction literacy, information literacy, branching literacy, and socio-emotional literacy.

SUPPORTING LEARNING IN THE HYPERLINKED CURRICULUM

Given all these changes in student behaviors and attitudes, how can we, as teachers, best support them in the hyperlinked curriculum? For it to function effectively we must have changes in instructional approaches and philosophies, changes in the classroom environment, changes in the structure and articulation between all elements of the educational system, and changes in the way administrations interact with and support the learning environment. As a preview of these changes, note that the title of this section is not "Teaching in the hyperlinked curriculum."

One important change is that the supporting resources must be located, designed, organized for searching, and made available to schools. Teachers will need to actively participate in this process, as their understanding of content and context are as important as the understandings of the students. The teachers must be prepared to learn and explore and provide guidance in how to learn, rather than didactic methodology. As in Fowler's fractal curriculum (1996) teachers would bear primary responsibility for this, but students and others would also participate, adding on to the existing resources and creating new ones as the need and interest arises. Given the profusion of wikis, blogs, and cross-platform content available, in addition to the various open-source initiatives for sharing and manipulating information, we are probably close to achieving the technical capacity needed to support the hyperlinked curriculum.

Another change is pointed to in Kahn's interview with Lord May (Kahn, 2005) which implies that the main idea of teaching is to push beyond current formats and "preset teaching goals" so that we are capable of "adapting to the teaching moment as it arises in actual experience" (p. 184). But both Kahn and May conflate the ideas of teaching using nonlinear sciences and teaching students *about* nonlinear science. Thus, they seem to be focusing on the content of instruction and curriculum rather than the method or structure. The content of the nonlinear sciences is important for students to experience though, because otherwise they will be unable to participate in and innovate in fields where nonlinear thinking is critical. In the hyperlinked curriculum, the experience of learning will be exceedingly nonlinear; students will start down many parallel paths, cross over to new ones in mid-thought and wander around their knowledge space. Their thinking will naturally tend toward the nonlinear and away from the strictly linear, cause-and-effect structure that dominates much of current scholastic work. Learning about the nonlinear sciences will naturally occur as the students encounter the concepts of feedback, chaos, and complexity in a variety of contexts.

Further changes will need to occur in the nature of teacher-student communications. Rasmussen claims that current interactions are dominated by regulations such as "pointing out that a contribution does not fit the subject of the communication, or by requesting that someone waits until another participant has finished speaking" (Rasmussen, 2005, p. 223). Thus, we have an imbalance: education is a social act predicated upon communication between psychic entities to help facilitate their self-change, but much of that communication is wasted. He sums up his theory of teaching and learning succinctly:

> …even though learning is performed by the student himself or herself, teaching can be adjusted in order to support the student's efforts at learning, which in the modern complex society chiefly means that that the most crucial task of teaching becomes the support of the students' handling of complexity through communication. (Rasmussen, 2005, p. 227-8)

This means that teaching will become more and more about communication among the participants. Student-teacher interactions will be important for feedback and reflection while student-student interactions will be essential for generating new ideas and relationships among them.

Even more challenging, this post-modern approach to curriculum will require explicit changes in the nature of instruction:

> The teacher must be capable of mastering a wide range of methods, which he can use according to where the individual students are in their learning process. This means that the teacher must be able to switch between different degrees of control in teaching from teacher-controlled class teaching through organization of teaching activities of a more independent nature to completely free forms of working. (Rasmussen, 2005, p. 231)

This will require a cadre of teachers ready to do different things; most importantly, they must be able to listen and observe students and provide prompts and suggestions *in the moment*. These teachers will require substantial content knowledge, a variety of pedagogical strategies and access to deeply integrated PCK. They must be reflective and constantly update their ideas based on all the evidence available, not just based on the content or their preset plans.

In some sense, the hyperlinked curriculum is the culmination and synthesis of the constructivist movement in conjunction with the technological developments of the recent decade. Since construction of knowledge is about both acquiring new "things" and then relating those things together, we see that the hyperlinked curriculum provides a model of curriculum that is the most similar to natural learning, as contrasted with academic learning. This approach embraces the relational nature of learning and makes it the foundation of education. It allows the curriculum to unfold from a temporally linear sequence of experiences and expand, fully filling the three-dimensional space of knowledge and sharing the burden for learning between the student and the teacher: the teacher must draw upon content knowledge and PCK to anticipate the needs and create opportunities to explore as many of the linkages as possible, but the student must follow these actively and reflectively.

This classroom collective – the integrated network of students, teachers and ideas – requires three things to function productively (Davis and Upitis, 2004, p. 126):

1. There is a need for "adequately compatible backgrounds" to "ensure conceptual redundancy through shared explorations, common practices"
2. There is a need to "embrace the conceptual diversity" in the classroom collective
3. And, in homage to Arthur Koestler's *The Act of Creation*, classroom collectives require the "opportunity for diverse ideas to interact."

In light of these, Jewett (2005) provides a critical point for engaging in the classroom collective: the distinction between observer and observed blurs. There is yin within yang.

This reciprocal and recursive reflection of the other always makes the next set of observations different, even when observing superficially similar events. Thus teaching always evolves and changes as the students follow new ideas in new orders. Many of us have probably experienced the situation of teaching two sections of the same course back-to-back, and finding that the second section did not work as well as the first because we tried to force it to follow the path or pattern that worked so well last period. We cannot perfectly reproduce a previously encountered entity in education; we must let the current one grow and develop while using appropriate insights and guidance to interact with it.

But if the curriculum emerges from students' individual explorations and it is constantly evolving, how can a shared classroom culture be useful? The answer is simple: conversations among participants will allow them to contrast and compare their perceptions and ideas. Shared problem-solving and application tasks will provide a chance for students to integrate and synthesize the multiple perspectives and views present in the classroom. Thus, learners must come to the shared experience prepared to participate fully, rather than passively receive. They must constantly experience disturbances or perturbations in order to move from current views and conceptions into new ways of thinking and connecting ideas in a self-referential way (Rasmussen, 2005). But even in a free and open environment, students tend to stay within their comfort zone. For this reason, the teacher must construct and identify problems for the students to encounter that will, when honestly engaged in by the students, push them away from their comfort zone. This will become particularly important in establishing a purpose for navigating a path in knowledge space. The ultimate goal for students will be to have them move beyond the need for teachers, selecting a problem or activity to explore on their own, based on both interest and need, and justifying the activity as one that will require them to learn new information or new ways to think, rather than verify their existing knowledge structures, as many current assessments seek to have students do.

Given the individual nature of the hyperlinked curriculum, many will immediately point out problems related to comparability of student performance. One student will have a different understanding of the content than another, not necessarily more or better, just different. But this is what differentiation of instruction is all about; we differentiate for product, process, and content. In a true classroom collective, all students benefit from all other students and ways of thinking; all students find their own way through, as they have always done, but now they are supported and encouraged to do so. And if the teacher has established clear activities and goals for success in these activities, these varied perspectives will lead to richer solutions which will interact recursively with the students' understandings through reflection. An important role for teachers in this differentiated curriculum will be to help students navigate the information web that they are exploring, guiding them to select new paths and reconsider old paths, monitoring the students to connect them to each other. Teachers will need to push students to reflect and reconsider their ideas and be prepared with many different strategies for encouraging different types of reflection.

Another significant component of enacting the hyperlinked curriculum is the need for reform in the educational system itself. We cannot simply change the way one level of the system functions. Nothing exemplifies this more clearly than the changes in the secondary mathematics curriculum in New York State in the 1990's and early 2000's. Every few years the curriculum underwent a significant change in content, just as teachers start to learn how best to work with the previous organization. But since the post-secondary mathematics programs did not make an effort to connect with each new secondary-level curriculum, students came to college "ill-prepared" for the courses in which they found themselves, courses which had not significantly changed since calculus became the starting point for college-level mathematics and mathematical applications to the sciences. To make the hyperlinked curriculum work, we must revise both college-level offerings and P-12 offerings. This will temporarily bring the new curriculum of each college into conflict, with worries about transfer credit, AP courses, and other confounding variables that make lasting change difficult. Once the transition is accomplished, though, these issues become easier to negotiate, as each student will have not only their own, acknowledged as valid, understanding, but will also be able to more thoroughly explain and justify their current understanding. This will make selecting next steps for each student easier, since we will, in essence, be doing it for all students, not just for transfers.

Throughout this reformation, the professional organizations must continue to provide guidance, frameworks, and examples of success. *Changing Core Mathematics* (Arney and Small, 2002) is one such example. These organizations must be careful, though, to not go too far. Currently they offer standards and guides, but as many have pointed out, most of the professional organization standards are too full of content for adequate coverage in a standard curriculum. To avoid this overload, teachers must be equipped with tools to determine the most important aspects of professional expectations. Qualitative tools, like those described by Ahlgren and Kesidou (1995) and more quantitative tools, like those discussed in Kuhn (2008) will be needed. They help to provide coherent rationale for grouping content and learning goals together into "curriculum blocks" which can be assembled into learning experiences that provide flexibility to adapt to local situations, rather than a rigid framework from which to teach.

Equally important to changes in the roles of teachers are changes in administration. Success will require that administration support and understand the change and the goals of the hyperlinked curriculum. A more integrated secondary mathematics curriculum with fewer artificial distinctions between the content of various mathematics courses has been envisioned by many (Reeder, 2005; Reynolds, 2005). And while this does free the students to explore the concepts as they arise and to follow the ideas as needed, it poses a problem: what if these students switch schools or teachers between the two courses which are definitely sequenced and distinguished in time, if not in content? How would the students fare then? Rather than use these issues as a barrier to implementing such integrated experiences, the administration can take a pro-active role to support them. With strong school administration to help make decisions about student placement and to work with parents and teachers to coordinate appropriate learning opportunities, many potential problems can be avoided. For this to happen, the administration would need to understand the instructional approach and make curricular sequencing decisions in light of this to help the faculty to support the students in their learning.

VIEWING THE HYPERLINKED CURRICULUM

Now that we have exposed some of the theory and problems of the hyperlinked curriculum, I wish to provide some examples that contain some aspects of such a curriculum. These examples are drawn largely from my own experiences and have been chosen to illustrate the hyperlinked curriculum in a range scales from a single course to entire undergraduate majors. One example is taken from speculative fiction, illustrating one way in which changes in technology may force us to develop alternative models of curriculum. A final example is taken from my learning and teaching experiences outside of the academic setting. As you read the examples, keep three things in mind. The first is the difficulty of describing these dynamic experiences in fixed written language. The second point is that one cannot separate the evaluation of a curriculum from the curriculum paradigm itself (Doll, 1993, pp. 172-4). Finally, it is difficult to explore changes in curriculum without discussing changes in instruction also; the two are inevitably linked.

The hyperlinked curriculum bears resemblance to other curriculum models in the literature, but these are often highly theoretical and lack practical examples. In a few cases, the examples are useful. Fowler's fractal curriculum and Doll's examples of how chaos and complexity can be used as metaphors to organize curriculum come to mind. These also illustrate the power of self-organization in agent-based models. Doll presents his work in a sixth grade class (Doll, 1989) as an example of giving students more responsibility and letting the curriculum emerge. And while it is exceedingly difficult to capture a dynamic process like this in a static description, it seems that his examples are really showing students learning well because of changes in instruction, not changes in curriculum. These changes seem to be mainly in the form of shifting emphasis onto higher-order thinking in Bloom's taxonomy, such as the creation of their own problems, instead of restricting learning to the lower level of applying procedures. This shift is a requirement in the hyperlinked curriculum; it cannot exist without engaging the higher levels of thinking.

Another possible criticism of previous examples and models for curriculum reform (the volume by Wolf and Hughes (eds., 2007) for example) is that most still represent the *product* version of curriculum as discussed in Howard (2007), since these models seem to all be focused on student learning outcomes. These are not as radical as the suggestions in Doll, Fleener, Trueit, and St. Julien (Eds., 2005) because, for the most part, students are treated more as sources of data for evaluating the curriculum, rather than participants in the development and exploration of the curriculum, as they are in the hyperlinked curriculum. What would students learn – about the disciplines, about learning, about themselves, about everything? – if they were part of the curriculum re-design process the way McCombs and Whisler (1997, pp. 89-97) discuss? Even sharing our thinking about why the curriculum is the way it is might go a long way here. Recently our department began work in defining our "ideal graduate" in mathematics. The list of qualities was very striking – almost no factual content was referred to in the list; rather they were almost all characteristics referring to their attitude toward learning and persistence in problem solving. The content mentioned was less about specific content and more about types of content. I suspect if we asked the students what they think the goal of the major is that we would find a very different list, probably one focused on the facts and techniques.

Integrating technology into a learning environment. This is a course designed for our master's program in Mathematics, Science and Technology Education. The candidates in the program are a mix of in-service and pre-service teachers in mathematics, biology, chemistry, physics and technology. The goals of this course are to help the candidates develop their technological skills and techniques, explore various educational theories related to the use of technology in teaching and learning, and to integrate these ideas into the development of practical tools and activities for their students. However, the candidates arrive on the first day with a vast spread of previous experiences and ideas about technology. They come from a variety of disciplines and work experiences; they teach in quite different settings, especially with regard to the prevalence of technology. In early versions of the course, all students completed a series of projects that helped them develop a set list of tools including a Webquest, an electronic gradebook, and so forth. And while the candidates chose the specific content of each project themselves so that one might create a Webquest related to geometry and another might focus on the history of communication technology, this process largely ignored everyone's unique situation.

The current course is much more open-ended. Students earn points by completing various projects in three different areas: skills, theory and application. Each area has a large list of possible projects, worth differing amounts of points, based on the complexity and time required. Students select their projects based on their time availability, their interests, their needs, and their current situation. Classroom experiences are designed to provide larger frameworks for looking at technology in teaching, and for learning a variety of tricks and tips that make using the technology easier. All students also complete a research project, chosen from a list of questions that are deliberately vague, requiring them to refine the topic based on their interest or ability. Through this experience, the candidates navigate the content and develop their own interpretations of it. These interpretations are shared in class and online, discussed, refined, and extended. This open-ended format allows students to complete work that they find important and useful according to a time frame they construct. This does put a heavy burden on the instructor to provide adequate guidance and feedback in the work, to assist them in finding decent resources, and to question their ideas and thoroughness. It also requires a more flexible but easy to use record-keeping system, since everyone is in a different place; this problem alone could prove the downfall of such a model of a course, but with modern spreadsheet and database tools, like Microsoft Excel's pivot tables, record keeping and monitoring of student overall progress is much easier (Green, 2008).

Interdisciplinary majors. At my school, I was fortunate to participate in the design and development of a new, interdisciplinary major. Originally, the Mathematics, Science and Technology Integration (MSTI) major was conceived as a second major for those pursuing a career in teaching at the elementary level. As such, its purpose was to provide an integrated way of looking at mathematics, science and technology, one that was substantially different from the approach in typical freshman-level discipline-based science and mathematics courses. The program evolved, though, to include three components. The first was a collection of courses in the program that all took an integrated look at some particular topic in mathematics, science and technology. The second component required students to select a second major; this was important both from a practical point of view to give the students more options after graduation, but also to embrace the interdisciplinary theme of the program. The final component was a series of research projects that led to a culminating experience in which students tied their two majors together. Note that "interdisciplinary" is distinct from "multidisciplinary" where students take a collection of courses from several different majors; that does not allow for integration. Instead, the courses in the MSTI major centered on themes like change and interdisciplinary topics such as astrobiology and network theory. These were, by and large, new courses that required new ways to teach, ways that involved learning along with the students and exploring ideas not at the control of the instructor, but as the need and interest arose in the students. And because the content of the courses was not nearly as rigidly proscribed as the content of a traditional math or science course, our program goals were much more about qualities of learning and thinking within the context of being scientifically and mathematically literate. These students were not expected to pursue careers in math or science, but rather look for ways to use mathematics and science within other fields, such as sociology or management.

The MSTI program did face a number of challenges, which eventually resulted in the program being placed on hiatus. The practical issue of trying to integrate multiple content areas into a single curriculum while also incorporating more affective or critical thinking/general core type goals required new approaches to the content and changes in our thinking about what content was most important. We faced significant challenges in recruiting students because it was a unique curriculum and was poorly understood by those most responsible for recruiting. Faculty were largely prepared to teach particular disciplinary courses, but not so eager to approach courses outside their primary fields. In seeking approval from the college-wide faculty for the program, many did not know how to think about such a non-traditional approach. But the students enjoyed the program and seemed to get a lot from it, and the administration trusted us and supported us to develop courses that maintained high standards. We faced political problems when significant changes occurred in the education programs, from which we drew the majority of our students. We also faced difficulties in scheduling the courses and squeezing the important ideas into the program due to constraints from the second majors; to solve this, we shifted from the traditional 3-credit hour course format to a new 4-credit hour format in the upper level courses. This allowed us to have a 3-credit class with an additional 1-credit independent study. These independent projects were tied to a particular course, but focused on building the student's research and independent project skills to prepare them for the capstone project at the end of the program. Another major difficulty involved defining appropriate pre-requisites for these unusual courses so that students were prepared to investigate the ideas without being hindered by previous experiences or a weak background. At the time, we did not quite realize how close we were to a new way of conceiving student learning experiences as a shared learning process through the hyperlinked curriculum.

Recently, I have been involved in developing an interdisciplinary major as an adult-degree completion program tying together liberal arts and critical thinking with social issues and business preparation. This program is meeting with many of the same difficulties as the MSTI major, but heightened because it involves many faculty from a variety of departments. Recruitment is difficult, especially with the recent economic downturn and the change in career and focus many potential students are facing. The program faces other issues with trying to recognize and incorporate the students' real life experiences while maintaining high academic standards. The key to the program development process has been identifying the guiding principles and outcomes we expect, then choosing, developing, and linking courses and experiences to these through projects and a portfolio.

Both of these programs embrace a new way of organizing learning experiences. It is based less on trying to give students all the minutiae of a field of study and more on developing habits of thinking and the ability to deal with ambiguous situations. All fields are changing rapidly; what is important changes, the details change, and often the main paradigms of thought change. In order to prepare students for this change "undergraduate programs require adequate flexibility to be able to respond to and provide cutting-edge learning experiences that originate from local and societal issues" (Hubball, Gold, Mighty, and Britnell, 2007, p. 101). This cannot be achieved if we insist on simply adding more courses dealing with new developments; we must rethink what is most important in order to avoid a curriculum that takes twenty years for students to learn enough to contribute to a field of study or even be prepared for the working world. The program should be carefully designed with principles of both vertical and horizontal integration. Hubball, Gold, Mighty, and Britnell (2007) describe vertical integration (p. 100) as "organizing faculty members into specific groupings to identify and disseminate examples of innovative course design and best teaching practices within subspecializations" which should be "challenged to develop flexible, progressively challenging, and responsive course work (throughout years one to four of the program) in order to align and integrate learning outcomes with learning experiences and assessment strategies." Horizontal integration requires that leaders of the curriculum change focus on "specifically designed courses [to] provide unique opportunities for students to apply and integrate learning outcomes and course work experiences from the individual disciplinary streams to the solving of progressively challenging multidisciplinary cases and problems throughout each year of the curriculum." These sorts of integration are becoming more and more important, even within traditional disciplines. The field of biology, for example, now regularly uses concepts from chemistry and information science, drawing on a great deal of extra-curricular knowledge.

Fairmont High. One of the best examples of a hyperlinked curriculum, to my mind, is purely fictional: Vernor Vinge's story "Fast Times at Fairmont High" (Vinge, 2001). The story is set during final exams for eighth grade students at Fairmont Junior High, whose motto "Trying hard not to become obsolete" (p. 744) illustrates nicely the nature of change. The school does use some traditional, discipline-based exams in areas like mathematics, but the questions are "harder than the old Putnam exam questions" (p. 748) which is made possible by the conceit of the story that computing is now ubiquitous: Every article of clothing, every building, almost every object in the world is connected to a single, massive computer network. Thus, students have nearly continual access to a web of electronic information. Further, due to optical and aural implants, the world they see is constantly overlaid with shifting graphics images and interwoven with private communications. The school's purpose is to "teach the kids how to learn, how to pose questions, how to be adaptable – all without losing their moral compass" (p. 744).

The story focuses on two students as they complete their two major final exams: the unlimited exam and the local exam. The local exam requires them to work without access to the net; they can use their "on board" computing power and storage, but their scores depend on "face-to-face [collaboration] with someone really different" (p. 751). Parents and students express some backlash to this, since it's not realistic, but the goal of the project involves showing that Fairmont is a good neighbor, situating it in the local community. In the unlimited exam, students have no boundaries on resource use. The only requirement is that the teams generate a minimum amount of money (equal to three times the annual tuition of the school per team member.) So at the same time, students are being tested in two very realistic, integrated ways, completing real world, practical projects that draw on all of their background and make use of all their abilities. The main character appreciates this fact, ironically by contrasting his preparation with his father's as an outdated software engineer for whom "three years of education had been spent for a couple years income" (p. 753) before losing his edge and employability. And while the story may be only science fiction, current estimates popularized in the “Did you know?” videos (available at http://www.shifthappens.wikispaces.com/) that claim that 75% of what a student learns in a four-year degree is obsolete by graduation. The students in the story will not, we are led to believe, fall prey to this obsolescence, because they are used to constantly grabbing, evaluating and integrating information about the objects they encounter. For them, the web has become an extended brain, one that they access unconsciously and continuously.

One gets the impression that the main character, Juan, is not a particularly strong student in the traditional sense, but that he is hard working and eager. His most valuable asset is his gift for problem posing that (after enhancement with a custom drug) allows him to quickly formulate questions in ways that his computing tools can solve. The children themselves realize the importance of critical thinking skills, pointing out that “[t]elling truth from fantasy was often the hardest thing about using the web” (p. 759). They are dependent to a large extent on their tools, as well. Working without the web on the local project felt like “having an itch you can’t scratch or a sock with a lump in it, only much worse” (p. 770). The most exciting aspect of the children’s work on the projects comes in the demonstration of their thinking processes. At several points in the story they demonstrate the ability to follow complex chains of reasoning, synthesizing many disparate facts into a coherent argument and evaluating the strength of the argument. The current century and the rapid pace of change demand a curriculum that helps all learners reach this level of thinking. Boyer (1995, p. 25) anticipates this story in his wish that “students in the classrooms of tomorrow will be encouraged to create more than conform, and to cooperate more than compete.” This is a perfect description of the projects the students are completing as a demonstration of their learning and abilities. They are not competing to get the most money; they have an objective reference for success. And they are not conforming to previous notions; instead they are free to explore the ideas and develop their project through their own creativity and interests.

Martial Arts. For many years now I have been involved in Isshinryu Karate, a martial art developed in Okinawa. Like many modern styles of Asian martial arts, Isshinryu recognizes the student’s progress with an external symbol: a colored belt. Requirements for each belt level are uniform within a particular school, but often vary from school to school. The belts help develop a sense of lifelong learning, through a constant progression from repetitive skills at the initial levels, to more detailed analysis of techniques and more creative interpretation and application of techniques as the learner moves to the rank of black belt. This presents a coherent body of study that works its way up Bloom’s taxonomy from factual recall and demonstration of specific procedures, like performing a side kick, to inventing one’s own kata to tie together various techniques into a coherent structure. And yet, karate does this while still providing room for personalization in terms of what individual elements are focused upon in order to progress to the next level. In other words, even though everyone must demonstrate the same basic level of skill, the balance of them changes; one student may have stronger kicks while another has better self-defense techniques and a third is better at sparring. Promotions then take on two roles. The first is a celebration of accomplishment. The second is formative assessment: identifying those places where a student needs to improve before the next promotion. Generally speaking, a good sensei does not schedule a promotion event unless the student has already demonstrated all of the individual requirements and the sensei knows the student is ready to move forward. There is no particular timeline for progression other than some expectation that a student will spend a specified minimum amount of time at each rank. This is the way assessment must occur in the hyperlinked curriculum: common expectations must be established, but the timelines for completing them and the degree of comfort with each should have some flexibility so that students can develop more naturally. An instructor or sensei can always prod a student to move faster or encourage them to try something new and push away from their comfort zone. In fact, the word "sensei" may be a more appropriate word than teacher in the hyperlinked curriculum; the word refers to "one who has gone before" rather than describing one who is the ultimate authority.

In presenting these examples, I have sidestepped an important issue. I claim these are successful examples, but have careful ignored the definition of "success"? And while there are probably many meaningful measures of the success of a curriculum change, one must deal with the question sooner or later. Is a change successful if it has broad support, or is lasting? Is it a successful if it meets accreditation requirements? Is it about "better achieving" student learning outcomes or better placement and accomplishment of graduates? Is there some internally defined measure or a combination of these? Is it increased recruitment? In other words, *what is the goal of curriculum reform?* It seems that there are very few intrinsically motivated curriculum reform efforts. Many of the examples are driven by external factors, such as accreditation issues or competition for students. The hyperlinked curriculum could be offered as an answer to all of these questions. Its goal is to help students take more responsibility for their learning and to develop deeper and more lasting connections to the world around them. In doing so, one anticipates that students will be a little more individual and less easy to categorize based on standardized tests, but that they will be more successful at adapting to change in their careers and the world at large, leading to long-term improvements in the accomplishments and performance of graduates and short-term gains in student motivation, participation and learning. This mirrors exactly the four levels of summative assessment discussed by Kirkpatrick and Kirkpatrick (as quoted in Hill, 2007, p. 35): student reactions to the program, learning results, behavior in the workplace and generally, and business results. One must plan for using all these types of data in evaluating the success of curriculum efforts. Only then can a complete picture emerge and meaningful decisions be made about changes. This implies a very long-term process of evaluation, though, which may be part of why education is often slow to make significant changes – consider that our current models of curriculum are drawn from a seventy-year old foundation. The hyperlinked curriculum, on the other hand, offers a faster adaptation to new data precisely because it is so interactive and collaborative. One could envision extending the learning environment to involve not just the students, the content, the teachers and the administration, but also to include potential employers and career advisors.

In the spirit of complete honesty I must also reveal another secret. The most intriguing and successful curriculum projects with which I have been involved are those for which students are not expected to have particular knowledge at the "next level." These terminal or sidebar courses are freeing in ways that courses like calculus are not. Students can find their way to wherever they get. Reflection on the journey and on the results inevitably shows that the students learned the "appropriate amount" for a course of that level. Thus, it may be that the most important feature in implementing a hyperlinked curriculum model is to avoid or minimize tightly sequenced courses, or to at least very clearly articulate what is really needed from course X in order to succeed in course Y.

CONCLUSION

Most educators would agree that, regardless of what exactly one means by the word "curriculum", its careful construction is a critical component of student learning and success. Based on work in the sciences and medicine, evidence-based practice in education is gaining stronger and stronger support. The hope seems to be that such objective studies can result in the development of the best possible curriculum for given content. But is this realistic?

Given the wide array of options for the basic structure of a learning experience (I have touched on only a few) and the nearly unlimited freedom we have for choosing the projection from the knowledge space into the curriculum-space, there currently exists no method to systematically search these options in order to locate the "best curriculum". When the concept of curriculum is expanded from strictly content and structure to also include the learners and the context of learning, the number of possible combinations becomes essentially infinite, although it is bounded by political, social, psychological and economic constraints. Thus, it seems unreasonable to hope for a scientific study of the options with the hope of producing the final word in curriculum development. And, such a final word would completely obviate the relational nature of teachers with the curriculum, eliminating any need for reflective practice and reinterpretation, which many consider to be the most important characteristics of a good educator. In short, we would be returning to a view of curriculum as a teacher-proof, static methodology.

So it seems that a systematic, reductionist search through all the variables influencing curriculum quality and success is not feasible. How about other tools from complexity theory and the new sciences? Can they help us develop the optimal curriculum? I suppose that one could, in principle, create a "genetic algorithm" to take several curriculum models and "mate/mutate" them to produce more fit offspring eventually leading to the best curriculum, but what are the appropriate measures of fitness to drive this evolution? I doubt anyone would advocate that success be measured strictly by student performance on high stakes tests. At the same time, we lack sufficiently detailed and accurate "input-output" models that would predict how a particular curriculum might impact a particular group of learners, so such a genetic algorithm would be overly simplistic at best. We would also need to clarify whether we are looking for whole-class success, whatever that would mean, or individual student success. And since the nonlinear sciences and post-modern curriculum theories are founded on the role of chaos to enhance small differences into huge impacts on learning, if our model is not accurate, it could lead us to construct a nearly worthless curriculum model.

The teacher-proof, perfect curriculum is an extreme example of scientific curriculum design or "evidence based reform" of teaching and curriculum methods. Certainly we must be collecting data and evidence to evaluate how well we are accomplishing our task as educators. The process is slow and there are no clear measures of achievement. The reductionism needed to conduct and interpret clear experiments for guiding education is impractical with the large number of variables present in a typical classroom (Flinders, 2003). These variables will inevitably lead to a variety of ways in which to successfully prepare students in particular contexts for particular goals with particular interests and needs. That is part of the beauty of the hyperlinked curriculum: it can take many forms, but all of them are examples of open systems that include the context of learning and the learners as major components of the experience, so that the experience automatically adapts to different students and different content-related needs. In that sense, one could view the hyperlinked curriculum as more of a meta-curriculum, a set of ideas and rules for designing particular instances of the learner-driven classroom.

Our students are already involved in a version of the hyperlinked curriculum. Many engage in countless hours of social networking, blogging, and gaming, using the tools of Web 2.0 to learn collaboratively about the aspects of their world that they find important and interesting. These tools allow for widespread collaboration, knowledge exploration, and creation with easy-to-use tools for manipulating existing information and adding new information. Just as exciting, these tools incorporate meta-information in the form of tagging, which allows the underlying connections among ideas to be made explicit. Clearly our students are invested in this. In this exciting real world (at least real to them) is it any wonder that the static, traditional curriculum fails to capture their interest in many cases? Frankly, we should be surprised that it has worked as long as it has. The hyperlinked curriculum provides a way for students to experience education in a more meaningful and relational context. They are already prepared to do this; indeed, they are eager to do this (Maloney, 2007).

Certainly a change in curriculum from current models to a more hyperlinked model requires a tremendous amount of change. Will the change be worth it? Will it be successful? So long as we are honest about what students need to learn and open about how they can experience this, so long as we are careful to reflect on the learning process as it unfolds and to help our students reflect on their learning, so long as we do our best to align our goals, methods and assessments, this change can be successful (Hubball and Gold, 2007). For the change to be worth the effort, we need to engage in constant assessment at all levels. We should not seek to compare the outcomes with previous models. Such comparisons are based on the reductionist approach to research in education and are not applicable to the multivariate changes required. Instead, more qualitative methods are needed to evaluate the curriculum's success in a modern setting.

These changes will obviously result in changes to all elements of the educational system. Teachers will have to explore and adopt a variety of strategies for working with students, students will have to step up and take more responsibility, and administrators will need to be familiar with the process enough to help teachers collaborate effectively for the good of the students. We will need new educational tasks – fewer worksheets and more realistic tasks and problems. These tasks can create the perturbations necessary for learning so long as the "tasks are chosen based on their potential for meaning to the students in their continued and developing understanding and the potential for the task to infuse the ongoing conversation" (Wesley in Reeder, 2005). Further, the tasks must have the "potential to provide challenge for the students and [create] discussion and questions that will perturb their thinking" (p. 255). Writing these kinds of high quality, thought-provoking questions requires that we construct questions to:

1. Be ambiguous
2. Ask *about*, not *for*
3. Explore vocabulary
4. Shift context and perspective (Davis, 1994)

In the end, evidence can inform our decisions and guide our work, but making the decisions will always be an art – we cannot construct a teacher-proof, student-proof, evidence-based, ideal curriculum. This art form is relational, constructed dynamically by all the participants. If we are to acknowledge this fact, we need to create educational experiences and programs where teachers can experience the hyperlinked curriculum's power and explore in a shared space how one might implement such a curriculum. Imagine, after an entire course of schooling in a hyperlinked curriculum, where the students are participating equally in decision making and seeing how and why the pieces are needed, that these students then become teachers. Preparing and certifying teachers would be a very different task in such a world.

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Chapter 4

LEARNING AND INSTRUCTION OF ORAL PRESENTATION SKILLS

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ABSTRACT

Oral presentation skills are recognised as central professional skills. In a majority of higher education curricula, courses are incorporated that centre on these particular skills. The present chapter starts with a conceptual discussion about oral presentation skills, and an in-depth discussion about the reliable assessment and evaluation of oral presentation skills.

But how can we design and develop an effective way to develop these oral presentation skills? It is difficult to find an answer to this question, due to a lack of a clear theoretical framework to guide instructional interventions. We introduce such a theoretical framework to understand how oral presentation skills evolve and can be influenced from an instructional point of view. As much as possible, we build on the scarcely available research results about the instruction of oral presentation skills. We adopt a social cognitive theoretical perspective towards self-regulated learning to develop a theoretical base for oral presentation skills instruction. In a systematic way, we link the theoretical base to the teaching and learning of oral presentation skills.

Four sub-processes of the observational learning cycle, derived from the social cognitive view, are put forward. Next we describe basic sub-processes of self-regulated learning, the cyclic model of self regulated learning and finally the transition from observation to self-regulated performance.

INTRODUCTION

Oral presentation skills are recognised as central professional skills (Campbell, Mothersbaugh, Brammer, and Taylor, 2001). In a high number of higher education curricula, courses are incorporated that centre on these particular skills (Morreale, Hugenberg and Worley, 2006). Some authors (e.g., Cooper, 2005) even stress that the teaching of these skills is becoming a more and more important curriculum element in higher education.

The central research problem of this chapter is related to the teaching and learning of oral presentation skills. First we develop the conceptual base to discuss oral presentation skills, and how these skills can be assessed and evaluated in a reliable way. Next we analyse learning processes related to complex oral presentation skills, and how the related theoretical base can be used to design and develop an effective way to develop oral presentation skills.

Conceptual Base

Next to the reasons why we use oral presentations, we will look for specific features of this form of communication.

The National Communication Association (Morreale, Rubin, and Jones, 1998) takes over a suggestion from Daly and presents three reasons to adopt oral communication: persuading, informing and relating. It is important to note that presenters can put emphasis on one specific communication aspect, but they nevertheless have to pay attention to all these aspects.

It is obvious that the emphasis is put on behaviour and that *knowing how* to present still is no guarantee for actually *performing* the expected behaviour and that motivation plays an important role in this context. We will elaborate this when presenting our theoretical framework. From a conceptual point of view, three elements can be discerned: knowledge, skills and attitudes. A shared core in most definitions of a competence is, according to Baartman, Bastiaens, Kirschner, and van der Vleuten (2007), that it consists of connected pieces of knowledge, skills and attitudes that are used to solve problems. We can therefore define the *oral presentation competence* as the combination of knowledge, skills, and attitudes needed to speak in public in order to inform, to persuade and to relate. The expression *speak in public* needs further explanation. A definition of speaking in public is hard to find. We can start with the definition of *speaking* from the National Communication Association (1998, p.4) “Speaking is the uniquely human act or process of transmitting and exchanging information, ideas, and emotions using oral language (…) communicators are required to organize coherent messages, deliver them clearly, and adapt to their listeners”. The word public is even harder to describe because the size of the audience is not clearly indicated. Some authors (e.g. Oomkes, 2000) emphasize that it is possible to have a big audience but do not provide a lower limit. The question subsequently arises if we can have a public speech with a very small audience, even when the audience consists of only one person? We adopt the point of view that at least one person must attend the oral presentation.

We defined earlier competence as a combination of knowledge, skills and attitudes but will nevertheless use the term oral presentation *skills* more frequently, because we are more interested in observable behaviour. This does not imply that we will neglect the fact that acquisition of the knowledge component should be related to the acquisition of the skills component. We certainly also acknowledge the important role played by motivational aspects, sometimes referred to as the attitudes of the learners.

We adopt the definition by McGuire used by Van Merrïenboer, Van der Klink, and Hendriks (2002) who sees attitudes as judgments that influence individual behaviour. Attitudes are relatively stable, but changeable (Van Merrïenboer, 2002).

OBJECTIVES OF ORAL PRESENTATION INSTRUCTION

The first step to be made by an instructor is to select appropriate educational objectives, and to decide how these can be attained. Given the lack of a clear theoretical base to direct oral presentation skills instruction, attention has to be paid to the validity of the objectives being put forward. In line with Omrod (2008), we adopt the term *instructional goals* when referring to general long-term outcomes and *instructional objectives* when referring to specific short term outcomes of instruction. Since oral presentations are considered to present a complex interaction of knowledge, skills and attitudes, we secondly have to consider the best way to evaluate the related learning objectives. This introduces the discussion about a reliable assessment approach.

Validation of Oral Presentation Objectives

What is a valid set of oral presentation objectives? We can state that the long-term outcome is to "deliver a good oral presentation". But this goal incorporates a long and complex list of related objectives. In addition, the specification of the term "*good*" also proves to be a very difficult process. Therefore, we centre in this section on a validation approach of instructional objectives related to oral presentation skills.

The first - and fundamental - question that arises is about the equivalence of assessment of oral presentations in the real life world and in educational settings. The quality of oral presentations in the real life world does not depend on judgements as adopted in educational settings. The quality of an oral presentation depends in a real life setting on the extent it helped to achieve the presentation goals: selling a product, convincing voters, getting a budget, getting approval for a project, getting things explained as to the causes of an accident … It can be questioned whether an oral presentation that is successful according to the educational standards is also successful in real life. We couldn't detect much research findings that help to bridge the gap between real life and education though some authors describe modest attempts. We give two examples: Pittenger, Miller and Mott (2004) adopted an outside assessment tool with the help of a business consultant and Church and Bull (1995) used employers to assess oral presentations. From now on we interpret validity from the educational point of view and describe the search for instructional goals and objectives from this point of view. This search is guided by state, national, and international standards. We illustrate this by building on two of the publications of the National Communication Association that delineate the outcome expectations for high school and college students. In a first publication of the National Communication Association (1998), the focus is on K12 education. Standard 10 centres on *speaking*, and lists 28 competency statements. We list the eight competency statements that deal with *presentation competences* below:

Knowledge

10.10. Identify strategies for appropriate and effective public communication.
10.11. Organize a message appropriately and effectively.
10.12. Develop an appropriate and effective introduction, body, and conclusion for a speech.
10.13. Choose and narrow a speech topic for a specific occasion.
10.14. Select appropriate and effective supporting material based on topic, audience, occasion, and purpose.
10.15. Modify a message to fit the audience.

Behaviour

10.16. Use verbal and nonverbal techniques to enhance a message.
10.17. Adapt language to specific audiences and settings.

In a second publication from the National Communication Association (Morreale et al., 1998), we find a list of four advanced skills as expected outcomes for college students in the domain of public speaking:

1. Incorporate information from a variety of sources to support message.
2. Identify and use appropriate statistics to support the message.
3. Use motivational appeals that build on values, expectations, and needs of the audience.
4. Develop messages that influence attitudes, beliefs, and actions

The outcomes, described in these two publications are rather general and need a further specification. Brown et al. (1997) tried to translate the eight public speaking competencies of the National Communication Association into specific and observable behaviour but this is not the only possible translation. In order to objectify our search for more detailed relevant features of oral presentations, we build on traditional taxonomies of learning objectives (Van Merriënboer and Kirschner, 2001). We can take the competency statement 10.11. as an example: Organize a message appropriately and effectively. A task analysis is helpful to yield the necessity to structure a presentation around main points. In order to do this a learner has to be able to manage a lot of information, to distinguish the main points, and so on.

If we consider as another example competency statement 10.16.: Use verbal and nonverbal techniques to enhance a message, task decomposition requires a very large and extensive process. Task analysis of aspects of nonverbal techniques, such as eye contact, speech delivery, and body language are far reaching. Therefore, we look for more efficient approaches to detect the relevant features of oral presentations.

A second approach builds on the approach of Taylor (1992) who developed a critical incident technique when asking instructors to recall effective and ineffective incidents in student presentations.

Thirdly, we can build on the approach of Estrada, Patel, Talente, and Kraemer (2005) that identified important oral presentation features by asking reviewers to make explicit the features and areas they want to improve in a presentation.

A fourth approach builds on an analysis of the learning content of textbooks used in this context. This is exemplified by the strategy adopted by Hess and Pearson (1991), when they examined 12 of the most popular textbooks and identified 24 principles of public speaking.

Fifthly, we can build on the consistent relationship between an instructional intervention and assessment, and therefore analyse assessment instruments used in classroom contexts. Identification of the assessment criteria and the weight attached to the different criteria is helpful to find indicators of what teachers consider of importance when evaluating oral presentations.

A review of these approaches shows that, even if we restrict ourselves to educational goals, different educators can have different opinions about what is a “good” presentation. The criteria they use can be categorized under two headings. One heading contains criteria that focus on the quality of the content of oral presentations and the second heading contains criteria about the quality of delivery. The relative importance given to those two headings is not always the same. It is influenced by the sort of oral presentation but also by other factors like cultural differences. Wiertzema and Jansen (2004) point e.g., at differences between the American culture, where the focus on the speaker gets full attention, and the Dutch culture, where the focus is rather on the content of a presentation. Gerritsen and Wannet (2005) illustrate cultural differences with respect to the evaluation of the introduction in a presentation by people from the Netherlands, France, or Senegal. But the relative importance of criteria can change even within the same culture. Frobish (2000) for instance points at the impact of television on the appreciation of the nature of oral presentation skills. Television made audience accustomed to the use of narratives, self-disclosure, and visual modes of persuasion. As a result, these features are now also expected to be presented in non-television delivered oral presentations (Frobish, 2000).

Reliability of Assessment Approaches

The second critical issue in relation to oral presentation skills is related to assessment. Especially the reliability of the assessment approaches presents specific problems. We assume that there has to be a consistent relationship between assessment and instruction. We will therefore deal briefly (because it is not the focus of this chapter) with the measurement of oral presentation skills after a general preliminary comment on the importance of reliability in the context of assessment of oral presentations.

The importance depends on the function of the assessments. If we emphasize the summative function of assessment, it is obvious that reliability is very important. If however we emphasize the formative function of assessment, the importance diminishes. We will elaborate the latter in the context of the theoretical framework for oral presentation instruction.

The literature does not provide us with a generally accepted measurement instrument. A large amount of measurement instruments can be found in the literature, but without any information about related psychometric qualities. The identification of rather generally accepted assessment instruments leads us to the work of Morreale and Backlund (2007) who discuss two assessments instruments for public speaking in their compilation of oral communication assessment instruments in higher education: *The Competent Speaker* from the National Communication Association and *The Public Speaking Competency Instrument* as developed by Thomson and Rucker (2002).

The Competent Speaker builds on eight competencies. Four competencies are about preparation (e.g., Provides appropriate supporting material based on the audience and occasion) and four about delivery (e.g., Uses physical behaviours that support the verbal message). Brown, Leipzig, and McWherter (1997) qualify these competencies as too abstract and too distant from the personal experiences of students. They tried to operationalize the eight competencies in terms of more specific and observable behaviour. But no study could be traced that made active use of the revised version of *The Competent Speaker*. Nevertheless, the elaboration of the latter has helped to ground the validity of the instrument of Thomson and Rucker (2002).

The Public Speaking Competency Instrument was developed by Thomson and Rucker (2002) and contains 20 assessment items that focus on concrete behavioural elements (e.g., I can identify a review of the main points in the conclusion). No studies could be traced building on this instrument.

Rodebaugh and Chambless (2002) mention the *Rapee Perception of Speech Performance Measure*. But they stress the fact that this instrument is biased towards assessing “bad” oral presentations.

One particular study compares three assessment instruments and concludes that the three instruments reflect a good validity (Carlson and Smith-Howell, 1995).

In our review of the literature, we observe that authors mostly build on an assessment instrument constructed for a particular study (e.g., Crossman, 1996). Another common denominator is the observation that the items of the available assessment instruments can be structured along two dimensions: a content and a delivery dimension (see e.g., Carlson and Smith-Howell, 1995).

Assessors, building on *The Competent Speaker*, described in the former paragraph, have to make a holistic judgment about the extent a speaker meets specific criteria by applying the qualifications unsatisfactory, satisfactory or excellent,. Nevertheless, the inter-rater reliability of *The Competent Speaker* is reported to be good (Morreale and Backlund, 2007). Dunbar, Brooks, and Kubicka-Miller (2006) suggest that the reliability is especially positively influenced by the limited amount of response categories, but that this negatively influences the feedback possibilities. The latter is expected to influence the potential of learning process. *The Public Speaking Competency Instrument* of Thomson and Rucker (2002) uses a Likert scale with five possible scores: poor (1), fair (2), average (3), good (4), and excellent (5), and also reflects a good reliability.

An analysis of the available studies building upon a self constructed assessment instrument reveals many differences with regard to their measurement approach. Firstly, the amount of items is very different. Daly, Vangelisti, and Weber (1995) for instance, developed a four item instrument. Wiertzema and Jansen (2004) used a 31 item instrument. Secondly, some questionnaires ask for a holistic appreciation, and others ask a very detailed analysis of oral presentation performance. A typical example of the latter is the questionnaire used in the study of Carlson and Smith-Howell (1995). Their subscale *Presentation* and *Delivery* ask to give a score on 30 points, and builds on ten items (e.g., gestures/movement) that are listed without giving examples or explaining the weighting of the different items (Carlson and Smith-Howell, 1995). It is striking that the authors report a good reliability level of this instrument, and that the use of the instrument without specific training or experience is possible without a negative impact. In the study of King, Young, and Behnke (2000), eye contact is defined as the number of times the speaker looks up and the length of the introduction is measured in seconds. This quantitative approach leaves no room for quality assessment and does not relate "looking up" to effective eye contact with the audience, nor does this approach relate the length of the introduction to the efficacy or impact of the introduction. A high score for these two indicators can be heavily biased. This is a typical situation where a high reliability can be at the expense of a low validity of the measurement. Jonsson and Svingby (2007) stress that this is particularly the case when the performance assessment criteria are too open. Wood, Marks, and Jarbour (2005) remark that sufficient detail in assessment criteria and indicators is often sacrificed in view of facilitation of the assessment activity. An attempt to introduce qualitative elements in assessment criteria and indicators results in many cases in subjectivity, and can have a negative impact on interrater reliability (Cooper, 2005). Woolf (2004) suggests therefore that assessment of this type of academic performance is closer to an "art" than to a "science". Examples of subjectivity are already evident in the language used; we refer in this context to words, such as *competent* (Pittenger, Miller, and Mott, 2004), *appropriate, relevant, and effective* (Cooper, 2005). Providing examples (e.g., Pittenger, et al., 2004) is the most cited solution to this problem.

Next to differences, there are also similarities between assessment instruments. Most instruments build on a Likert scale to rate performance (e.g., Brown and Morrissey, 2004), and are complemented with sets of examples, as indicated earlier. When samples of behaviour are supplied as examples, assessment instrument are often labelled as *rubrics*. This approach is helpful to distinguish between levels of performance in view of a particular criterion (Hafner and Hafner, 2003). The adoption of a rubric therefore helps to boost the reliability of the assessment instrument, and procedure (Jonsson and Svingby, 2007).

How to Design Instruction of Oral Presentation Skills?

Analysis of the Literature

A literature review shows that earlier studies about instructional interventions to develop oral presentation skills reflect a weak theoretical and empirical base. They are also very varied in the way instructional interventions are contextualized. Several studies are situated in an economics education department (e.g., Brown and Morrissey 2004) or in the medical education department (e.g., Sarang, Kogan, Bellini, and Shea, 2005). We also traced studies in other departments such as law schools (Cooper 05; Edens, Rink, and Smilde, 2000); geography settings (Church and Bull, 1995; Hay, 1994); applied sciences (AlFallay, 2004); psychology education (Taylor, 1992), and nursing (Higgins and Nicholl, 2003), international postgraduate research students enrolled in several disciplines (Adams, 2004), Chinese engineering students (Mueller, 2000), US. Naval Officers (Thomas et al., 1994) or culinary arts and pastry arts students (Crossman, 1996) as participants.

To structure the large variety of studies, they are discussed by distinguishing two clusters of studies: (1) studies that centre on the way the instruction interacts with learner *behaviour,* and (2) how *person* related variables interact with the instructional intervention and subsequent *behaviour* of learners. We recognize that it is not always easy to categorize studies on this basis, but in most studies one of the determinants is stressed. In addition, this clustering will also facilitate the subsequent elaboration of a theoretical framework.

Instruction and behaviour

According Taylor and Toews (1999), a focus on instructional variables introduces four key elements that define the learning environment: (1) First, learners need to know what to do; (2) they need to master the basic and conditional knowledge in view of concrete performance; (3) the beliefs of learners about their oral presentation skills should be considered; and (4) learners should learn from their experience. Hay (1994) adds to this the importance to initially reduce presentation fear. As will become obvious in the next paragraphs, also other instructional components are explicitly discussed, such as delivery format, feedback, the nature of assessment approaches, etc.

Levasseur, Dean, and Pfaff (2004) interviewed teachers during advanced public speaking courses about their pedagogical practices. The results reflect the key elements mentioned by Taylor and Toews, such as learning from theory and models, practice, feedback, and self-criticism. But Levasseur et al. also reported a tension in the teachers between (1) their theoretical conceptions and actual instructional practices, and (2) between form and process. The latter tension refers to instructors who either spend more time on additional speech genres or on the thought process to analysing speech situations (Levasseur et al., 2004).

In the research literature about oral presentations, a number of studies focus in particular on the delivery format for instruction. Tanian and James (2002) compared e.g., a face to face course with a print-based self-study course in which students videotaped their own presentations outside the classroom. He concluded that the latter approach was not as effective as the face to face approach in the classroom with a live audience.

Aitken and Shedletsky (2002), Clark, and Jones (2001) and Benoit and Benoit (2006) report about online instructional models for public speaking courses. Aitken and Shedletsky (2002) adopted an online interactive textbook but reported that most students still are present on the campus to deliver their speeches. Clark and Jones (2001) gave students the option between an online and a traditional format, and compared communication apprehension and self perception of public speaking abilities. No differences were found, but Clark and Jones (2001) warned that not all students fare equally well with either format, because they observed clear differences in students preferences for a specific format. The online format was e.g., preferred by males, and by learners who rated themselves as good independent students (Clark and Jones, 2001).

Calcich and Weilbaker (1992) studied the optimal number of presentations in view of enhancing presentation performance, and found that giving two presentations was better than giving one or more than three presentations.

The following instructional elements seem to have been studied in most detail in the literature: behaviour modelling and the delivery of feedback. In a series of studies, behaviour modelling has been adopted as the key instructional strategy to help learners to develop the oral presentation skills. Behaviour modelling is for instance used by Adams (2004), Pittenger et al. (2004), Taylor (1992), Tucker and McCarthy (2001) and Wiese, Varosy, and Tierney (2002). Adams (2004) compared the learning impact of working with non-expert and expert models, and found a puzzling lack of learning from the expert models and a significantly larger learning gain when students observed the non-expert. Pittenger et al. (2004) also report about the involvement of a mix of “good” and “weak” model speakers whereas Taylor (1992) only adopted a “good” model.

A number of studies centre on learning from getting feedback after giving oral presentations. Bourhis and Allen (1998) summarized twelve studies about the use of videotaped feedback and found a positive effect on public speaking skills and on attitudes of students towards the course. Since results also indicated that there was no significant increase in anxiety in the presence of a camera, Bourhis and Allen (1998) concluded that videotaped feedback could be an effective instructional strategy for teaching oral presentation skills. Hinton and Kramer (1998) explored the impact of video feedback related to oral presentations, on students’ self-reported levels of communication competence and apprehension. They found limited support for their hypotheses. Results suggested a differential impact depending on initial competency and apprehension levels. Jensen and Harris (1999), and Voth and Moore (1997) studied the instructional benefits of incorporating videotaped speeches in a public speaking portfolio, and reported next to general benefits of portfolio use, such as learning through self-assessment, also benefits specific to the use of video like the possibility to do repeated observations of (parts of) their speeches on their own or in the presence of the teacher. They also mention that these videotaped speeches are tangible evidence of their competence to potential employers (Voth and Moore, 1997). King et al., (2000) examined the efficacy of immediate feedback during presentation performance versus delayed feedback. They found that immediate feedback was superior to influence processes that are rather immediate (e.g., enhancing eye contact). Delayed feedback was superior to influence that required deliberative and effortful processing (e.g., changing the length of an introduction of a presentation). Haber and Lingard (2001) conducted a small-scale qualitative study and warn that implicit and a-contextual feedback generates dysfunctional generalizations. Smith and King (2004) reported that students differing in feedback sensitivity reacted differently to high or low intensity feedback.

A growing number of studies report the adoption of peer- and self-assessment in the learning process of oral presentation skills (AlFallay, 2004; Campbell et al., 2001; Cheng and Warren, 2005; Hafner and Hafner, 2003; Hughes and Large, 1993; Jensen and Harris, 1999; Langan et al., 2005; Magin and Helmore, 2001; Oldfield and Macalpine, 1995; Patri, 2002; Price and Cutler, 95; Selinow and Treinen, 2004; Voth and Moore, 1997). In some studies, only part of the research focuses on peer or self-assessment (e.g., Fallows and Chandramohan, 2001). In other cases, group presentations are assessed (e.g., Miller, 2003) or assessments centres are set up (e.g., Clapham, 1998) that comprise an oral presentation.

Person related variables, instruction and behaviour

The importance of person related variables in relation to instruction, and behaviour is clear from the available studies. These studies seem to help to answer three basic questions: (1) Can I carry out this presentation task; (2) Why am I doing this presentation task, and (3) How can I carry out this presentation task (Miltiadou and Savenye, 2003).

Answers to the first question stress a persons' individual perception of his/her abilities. This is generally described as self-efficacy (Brown and Morrissey, 2004). Adams (2004) detected that observing a non-expert model enhances to a larger extent self-efficacy, as compared to observing an expert model. Two other studies reported an enhancement of presentation self-efficacy. Brown and Morrissey (2004) used a verbal self guidance training and Tucker and McCarthy (2001) used service-learning to influence presentation self-efficacy. In the latter study it is hypothesised that self-efficacy is influenced by influencing attribution processes of learners (Tucker and McCarthy, 2001). When presentation self-efficacy is very low, this is referred to as speech anxiety (see e.g., Behnke and Sawyer, 2000).

Why should I perform this presentation task? The only study dealing with this question is a correlation study by Carrell and Menzel (1997) who found that the motivation of learners is positively associated with their public speaking competence.

How can I perform the presentation task? Menzel and Carrell (1994) found that the quality of speech performance correlated positively with preparation time and number of rehearsals. But, several other authors warn that more preparation is not effective for all presenters because it is also important what activities presenters deploy during preparation (see e.g., Ayres, 1996; Carrell and Menzel, 1997; Thomas et al., 1994).

Some conclusions based on the literature review

In the former paragraphs, a set of studies about oral presentation skills has been discussed. A number of critical observations have to be made.

If authors refer to a theoretical framework, this framework – implicitly or explicitly - mostly builds on observational learning or modelling. Studies that refer to self-efficacy, also adopt a motivational construct that is connected to the same theoretical framework. However most of the literature concerning in the domain of learning and teaching oral presentation skills is characterized by rather a-theoretical conceptions and approaches. This first weakness points at an urgent need to approach oral presentation skills from a comprehensive theoretical perspective.

A second weakness observed in the available studies is the lack of empirical evidence supporting the claims of the instructional interventions, or the impact of particular person related variables. This is also partly related to the research design of many studies. Bayless (2004) did e.g., not adopt an experimental design and did not provide quantitative evidence supporting changes in oral presentation skills. Neither did Grace and Gilsdorf (2004). Green et al. (2005) report a general increase in grade average scores of students being rated as excellent in oral presentation skills as compared to a previous academic year; but this increase is not statistically tested. Calcich and Weilbaker (1992) reported significant differences in a number of quantitative measures but without controlling for initial differences.

In addition, different studies report conflicting or very different results. Seibold, Kudsi, and Rude (1993) cite a study reporting a 20% gain in oral presentation skills, but without involving a control group. Students in a study of Wiese et al. (2002) achieved an increase of 35% in presentation quality scores. In contrast, Crossman (1996) rather reported a small increase, between 3.9% and 11.6% in five different presentation skills areas. In the study conducted by Seibold et al. (1993) 12 out of 16 presentation skills had improved. Yu (2002) also reports that students in his small scale study did not improve on all the presentation skills.

Learning and Teaching Oral Presentation Skills: Towards a Theoretical Framework

The social cognitive perspective and self-regulated learning

As stated above, the literature does not provide us with an all-embracing theoretical framework to ground approaches towards learning and instruction of oral presentation skills. Few studies present a clear link between a theoretical framework and a specific research design.

As suggested earlier, we adopt a social cognitive theoretical perspective towards self-regulated learning to develop a theoretical base for oral presentation skills instruction (Bandura, 1997; Schunk, 2001a). The choice of this theoretical framework is influenced by a number of considerations. First of all, we want to build as much as possible on the *available literature* about the instruction of oral presentation skills. Since we could conclude that behaviour modelling and feedback play a dominant role in earlier studies, these constructs fit the proposed theoretical framework. Modelling is central to the theory of Bandura (e.g., Bandura, 1986) and feedback plays a dominant role in the production processes of self-regulated learning (e.g., Nicol and Milligan, 2006). This is also the case for the self-efficacy construct (e.g., Bandura, 1997). Another consideration arises from the long term character of the *development process* of oral presentation skills, described as central professional skills. We consider that learners will be able to display personal initiative, perseverance, and adaptive skills. This fits into the definition of self-regulated learning as stated by Zimmerman (2001). A third consideration is that the social cognitive theory is very well suited to explain the development of *complex* behaviour such as oral presentation skills (Bandura, 1986, 2005). This theoretical approach has especially been adopted in competency training settings. According to Taylor, Russ-Eft, and Chan (2005) this perspective "…has become one of the most widely used, well-researched, and highly regarded psychologically based training interventions approach…" The choice for this theoretical approach is also in line with the "behaviour modelling" approach mentioned earlier. The emphasis on the self-regulated nature of learning is also in accordance with current views of learning that see *students as active* "seekers" and "processors" of information (Schunk, 2001a). Like Zimmerman (2000, p.14) we refer to self-regulation as "(…) self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals". As indicated in the overview of Zimmerman (2001) there are a variety of learning theories focusing on self-regulated learning. It follows from our initial choice for the social cognitive theory, that we adopt the social cognitive view towards self-regulated learning (e.g., Schunk, 2001a). Because we are particularly interested in the development of skills and what learners show (and not what they know), *motivation* will be crucial. Consequently we have to turn to a theory in which motivation plays an important role. Within the variety of motivation oriented theories, we do not take extreme positions such as the view that motivation stems from external rewards (see operant learning approach) or the view that motivation arises from a sense of self-esteem (see phenomenologists). We rather adopt an in-between position, as reflected in the social-cognitive perspective towards motivation (Zimmerman, 2001). The volition view introduces the motivational construct "volition". This introduces a discussion in which we follow Zimmerman and Schunk (2001) who state that there might be a reason to question if this construct is not related to the motivational constructs "expectation" and "goal". The social cognitive approach nevertheless stresses the importance of volition by referring to some drawbacks of the Vygotskian point of view (Schunk and Zimmerman, 1997). Schunk and Zimmerman refer to the assumption of Vygotsky that modelling leads to passivity and conclude that an extra emphasis is necessary on the motivational processes in interaction with learning processes.

In the next paragraphs we elaborate in detail the social cognitive approach towards human behaviour and learning, and the conceptual base regarding self-regulated learning.

The Social cognitive view towards human behaviour and learning

The social cognitive theory adopts an "agentic" perspective toward human functioning, and distinguishes four core properties of human agency (Bandura, 2006): intentionality, forethought, self-reactiveness, and self-reflectiveness. *Intentionality* and *forethought* imply that humans shape their behaviour on the base of clear intentions, implicit/explicit goals, and anticipated outcomes. *Self-reactiveness* implies that people motivate themselves to monitor and self-regulate their actions. S*elf-reflectiveness* causes humans to reflect upon their actions and thoughts, and look for adjustments if necessary.

It is interesting to notice that the social cognitive view is compatible with behaviourist approaches that stress the role of reinforcement. Bandura recognizes the role and impact of direct reinforcement when e.g., a learner reproduces the observed model behaviour, and subsequently receives a reward (vicarious experience). But, Bandura does not simply "copy" the role of rewards in his theory. He adds to the reinforcement construct the role of forethought and anticipated outcomes; thus giving a central role to internal cognitive processes of learners in the learning and reward cycle. (Woolfolk, Hughes, McMillan, and Walkup, 2008). This helps to distinguish the social cognitive view from basic behaviourist approaches.

A basic assumption of the social-cognitive framework is that behaviour is not only influenced by individually anticipated outcomes, but by a combination of environmental factors (e.g., an instructional intervention) and personal characteristics (Urdan and Schoenfelder, 2006). This originates from the triadic reciprocal causal model of human functioning of Bandura (1997) who discerns three major classes of determinants of human functioning: behaviour, personal factors, and the environment (see figure 1). Applied to the object of this chapter, this implies that oral presentation-performance (*behaviour*) is the result of the interaction of instructional intervention (*environment*) and student characteristics (*personal factors*). Reciprocity indicates that oral presentation performance, the instruction, and the students' characteristics influence one another bi-directionally as depicted below in figure 1. We illustrate the reciprocal nature of the relationships with a number of examples:

- *Reciprocity between instruction and oral presentation performance*: the instructor can ask to deliver a 2 minute speech, but when students run out of time during their oral presentation, he adds another minute to carry out the assignment.

- *Reciprocity between learner characteristics and instruction*: when students are hesitant to speak in public, the teacher alters the instruction – e.g., he adopts a small group setting instead of whole-classroom instruction - in order to make the learners feel more comfortable and be more confident.

- *Reciprocity between presentation performance and learner characteristics*: giving a good presentation performance can boost student beliefs about their capacity to speak in public (self-efficacy), consequently these beliefs can boost performance during a subsequent oral presentation.

Bandura (1986) starts his description of observational learning with the remark that if we would only learn through experience, learning would be greatly retarded. Fortunately, he adds, most human behaviour is learned by observation through modelling (Bandura, 1986). A common misconception about modelling is, that it resembles mimicry or imitation processes (Bandura, 2005). Modelling has a much specific function, as will be explained in the next paragraphs.

Modelling helps the learner to abstract information about the structure of the observed behaviour and to extract the underlying principles that govern this behaviour (Bandura, 2005). Secondly, modelling deals with inhibitory and disinhibitory effects about behaviour previously learned (Bandura, 1986). In the context of modelling, the following three questions are crucial: (1) Can I perform this behaviour?; (2) What are the consequences of performing this model behaviour?; (3) Will I experience similar consequences when performing the observed behaviour? If the answers to these questions are positive, inhibitions to perform the observed behaviour will be weakened, resulting in the disinhibitory effect of modelling.

Observation of a model is but a first step in learning new behaviour. According to the social cognitive theory, this learning cycle is governed by four constituent processes, namely attentional processes, retention processes, production processes, and motivational processes (Bandura, 1986). In the course of this learning cycle, the learner first has to pay sufficient attention to the model and the knowledge/skill to be learned (attentional processes), and has to process and store the information obtained in this way (retention processes). Next he/she has to apply the newly stored knowledge/skill (production processes). The learner has to be sufficiently motivated throughout the whole process (motivational processes). The four sub-processes will be outlined below in view of grounding the instructional design of an instructional intervention to support the development of oral presentation skills. We complemented the social cognitive theory with findings from the cognitive load theory and the cognitive multimedia theory. In a systematic way, we will link the theoretical base to the teaching and learning of oral presentation skills.

Attentional processes

The learning process cannot start unless learners accurately observe what has to be learned from the model, and several factors related to the model and to the observer influence this observation. The attractiveness of a model and contrast modelling of poor and good performance can help to heighten attention. Baldwin (1992) and Schönrock-Adema (2002) found that trainees who were exposed to both positive and negative models achieved higher scores on behavioural generalization. Attentional involvement is also affected by the consequences experienced by the model because performance that is rewarded gets more attention. The observers' cognitive skills and prior knowledge but also the anticipated benefits of modelled skills will influence his perception.

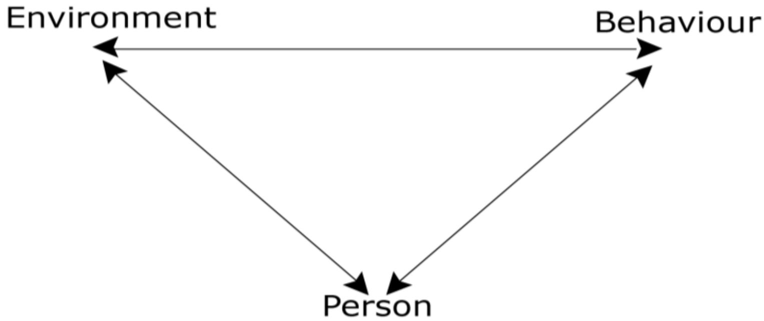

Figure 1. The triadic reciprocal causal model of human functioning.

Retention processes

The learning process is halted unless the demonstrated behaviour, reflecting the standards and criteria, is processed, and stored in memory. It might also be possible that processing the full content of the demonstrated behaviour is hindered, because of capacity limitations of working memory. We come back to this limitation, when discussing cognitive load theory (see e.g., Sweller, Van Merriënboer, Paas, 1998). The retention processes build on the human cognitive architecture that reflects a limited working memory and an unlimited long-term memory. In long-term memory we can store schemas that integrate several elements and help to free working memory capacity (Sweller et al., 1998). Cognitive load theory helps to understand how information presentation in e.g., an instructional intervention helps or inhibits the retention processes and subsequent storage of information in long-term memory (Sweller, 2006). This builds on a clear distinction between three sorts of cognitive load. *Intrinsic cognitive load* refers to the intrinsic complexity of the learning content being studied and represented. Intrinsic cognitive load cannot be prevented. In contrast, the two other types of cognitive load can be influenced through instructional design. The way the material is – badly - represented can invoke cognitive load; this is called *extraneous cognitive load*. In contrast, when supportive representations have been developed or used, it will lessen cognitive load, resulting in what is called *germane cognitive load*. In this case, the representation (e.g., the multimedia design) of the instruction promotes the development of schemas, and subsequent storage in long-term memory. Using tables, graphical representations, animations, etc. can therefore help to decrease extraneous cognitive load, and increase germane cognitive load. A variety of design principles can be adopted to increase germane cognitive load (Sweller, 2006).

In the context of instruction that fosters oral presentation skills, the multimedia nature of the instruction format will be of importance. The cognitive theory of multimedia learning (Mayer, 2001) stresses e.g., the importance of presenting information in a visual and an auditory way; this is also referred to as the 'dual channel assumption' (Paivio, 1978). Retention is enhanced when instruction presents the learner with both visual and audio cues. An advantage of respecting the dual-channel assumption is that we can manage the cognitive capacity of both cognitive processing channels. Recently also Wouters, Tabbers, and Paas (2007) presented comparable instruction guidelines to promote learning on the basis of video-based models. Next to the above, they stress the importance of pacing. Higher learning performance is associated with learner-control of e.g., the video based instruction materials (e.g., control of speed, backward and forward screening). In this way learners are able to "adapt" the video-based model to their cognitive needs.

Production processes

The social cognitive learning perspective stresses the importance of giving opportunities to practice behaviour that has been modelled and processed in view of retention in long term memory. This implies that we have to invite learners to perform the expected specific behaviour. This behaviour will elicit feedback when it has been assessed.This introduces issues that have to be considered when developing instructional formats to develop oral presentations skills.

The role of assessment in learning and instruction of oral presentation skills. We already stated that feedback and assessment are key topics in the available research literature about the learning and teaching of oral presentation skills. But feedback and assessment also play a crucial role in the learning circle according to the social cognitive perspective. This also fits into the current trend in didactical theories to integrate assessment into the learning process. This is in particular clear when we observe an increased implementation of self- and peer assessment approaches and the growing use of assessment as a tool for learning (Segers, Dochy, and Cascallar, 2003). The same applies for the teaching and learning of oral presentation skills. Because of this, we discuss these topics more in detail. We start with defining the key concepts *assessment* and *feedback*, next we introduce the concepts *monitoring* and *calibration* and end with observations about *internal* and *external* feedback.

Defining assessment. In line with Baartman, Bastiaens, and Kirschner (2004) we adopt the British definition of *assessment*, referring to methods for measuring as well as judging a learner's competence. This is different from the American definition that limits assessment to the actual measurement and requires the use of the additional concept *evaluation* to refer to the judgment about the behaviour being assessed (Baartman, et al., 2004).

A typical dichotomy in concepts related to assessment is based on formative and summative assessment (Russell, Elton, Swinglehurst, and Greenhalgh, 2006). Formative assessment is defined as "assessment that is specifically intended to provide feedback on performance to improve and accelerate learning" (Nicol and Milligan, 2006, p. 64). Summative assessment is concerned with summarizing the achievement status and is used at the end of a course, especially for the purpose of certification or qualification (Sadler, 1989). The difference between the two functions of assessment is not always clear. Taras (2005) notes in this context that formative feedback is in fact a type summative assessment (the judgment) enriched with feedback. Summative assessment largely remains the responsibility of teaching staff (see e.g., Curle, Wood, Haslam, and Stedmon, 2006).

In this chapter we focus especially on formative assessment and analyse the possible role of learners in this process. Involvement of students in assessment can be organised in two ways: peer assessment and self-assessment. In peer assessment, according to Falchikov (2005, p.27), "(…) students use criteria and apply standards to the work of their peers in order to judge that work". Building onto the latter definition, we state that in self-assessment students use criteria and apply standards to their own work in order to judge that work.

Integrating assessment into the learning process, directs the attention to the influence of assessment on the actual learning process. This is referred to as the consequential validity of assessment. Consequential validity is important since it determines the extent to which learners will make use of feedback information in their later learning process (Gielen, Dochy, and Dierick, 2003). Next to this post-assessment effect, there is also a learning effect during assessment when learners need to reorganise their knowledge or use it in a different way (Gielen, et al., 2003).

This shift in the place and role of assessment in the learning process is sometimes called a change from a *psychometric* view to an *edumetric* view (Gielen, et al., 2003). The latter position builds on criterion referenced measurement that helps learners to compare their own performance to specific criteria. The psychometric position rather compares learners to each other (Baartman, 2008). This shift also explains the hypothesis of Gibbs and Simpson (2004) that feedback that is imperfect from a psychometric point of view but delivered immediately after performance, might have a stronger impact than feedback that is perfect from a psychometric point of view but provided four weeks later. Gibbs and Simpson (2004) furthermore stress that assessment will only support student learning, when sufficient feedback is given, when the feedback is received and attended to, and acted upon by the learner. Yorke (2007) however regards these extra requirements as too teacher-centred that also ignore the affective dimension in learners.

Defining feedback. Nicol and Milligan (2006, p. 64) give the following definition: “feedback is information about how a student has performed in relation to some standard or goal (knowledge or results)”. Because we want learners to use the information provided, we adopt in this chapter the definition of Taras (2005, p.470) “Feedback is information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way”.

Feedback is critical to enhance learner achievement (Marzano, Pickering, and Pollock, 2001). But King et al. (2000) warn about the naive assumption that “more” feedback is better. Also Kluger and DeNisi (1996) argue that negative side-effects of feedback are ignored by researchers and identify a number of variables that moderate the effect of feedback; e.g., the nature of the task. The former makes it clear that feedback has to meet some requirements in order to be effective. Nicol and Milligan (2006) propose seven principles for delivering good feedback. We build on two of his principles. The first principle requires clarifying what “good” performance is. This can be linked to the third component of the modelling process, the production subprocesses (Bandura, 1986). The second principle states that “good” feedback should facilitate the development of self-reflection and self-assessment. Nicol and Milligan (2006) advice to use self-assessment tasks to achieve this goal. To conclude, we add that according to William (2008) feedback should cause thinking and provide guidance for improvement and consequently look forward to the next assignment, and should therefore be used during successive performance.

Monitoring and metacognitive monitoring. Feedback can be *external* or *internal*. Instruction can provide external feedback, but has to foster at the same time the development of internal feedback mechanisms. The ultimate goal is that learners adopt self-monitoring. Winne (2004) distinguishes between monitoring and metacognitive monitoring. Monitoring happens when someone compares his/her presentation with a standard about e.g., ‘giving a conclusion during a presentation' and notices that he/she did not present a final conclusion. Metacognitive monitoring implies that the same person continuously screens the personal behaviour by saying "I have to think in advance about conclusions and write them down…." Metacognitive control interferes with actual performance and is related to decision making about continuing, adapting or abandoning behaviour. If monitoring is the basis of metacognitive control, it has to be accurate. For instance, when somebody concludes during monitoring that he speaks loud enough, although this is not the case, he will make the wrong decision and will not adapt his behaviour. This is called "poor *calibration*" of behaviour.

Calibration. "Calibration is a measure of the relationship between confidence in performance and accuracy of performance" (Stone, 2000, p.437). Accurate calibration seems a necessary condition for productive self-regulating learning (Winne, 2004) and to attain a high achievement level (Garavalia and Gredler, 2002). The question arises how well learners are capable to assess their own performance. Building on a meta-analysis of research about self-assessment Falchikov (2005) concludes that some students seem to master this ability, but other not. Some authors (Kruger and Dunning, 1999) state that students, who are less skilled, overestimate their performance and miss the metacognitive ability to calibrate their performance. Rust, Price, and O'Donovan (2003) come to the conclusion that women are more likely to underestimate their performance, whereas males tend to overestimate the quality of their performance in a self-assessment context.

External and accurate feedback can enhance calibration (Stone, 2000). Watching one's own recorded oral presentation can be an excellent help to provide accurate feedback information, resulting in higher performance (Bourhis and Allen, 1998). We can relate this instructional design guideline to the observation of Schunk (2001a), who reported that self-modelling by observing one's own videotaped performance brought about significant cognitive and behavioural changes.

In addition, experts can provide additional external feedback. Recent studies point especially at peers as providers of external feedback (Birenbaum, 2003). This leads us to the question about the quality of peer assessment or how this assessment approach resembles teacher assessment. It can be stated that peers are susceptible to the same rating errors as teachers. Rating errors that are applicable to peer assessment have been summed up by Sluijsmans, Moerkerke, van Merrïenboer, and, Dochy (2001) and comprise personal differences in standards and rating styles, the extent to which they distribute grades, and different opinions about the rating tasks.

Hanrahan and Isaacs (2001) have raised concerns about student perceptions of peer assessment, and their analysis revealed eight general dimensions and twenty higher order themes. Their results showed that students were for instance concerned about their inexperience with marking, that they felt uncomfortable critiquing each others' work and remarked that the process was not taken seriously because it did not count for final marks. Students also complained that it was too time-consuming and asked for feedback about their assessment (Hanrahan and Isaacs, 2001). Despite these problems, Falchikov (2005) concludes on the base of her meta-analysis that there is a strong correlation between peer and teacher marks (mean overall value $r = .69$).

In summary, three sources of feedback can be used to direct and influence production processes: (1) information obtained via self-assessment, and external feedback sources from (2) peers, or (3) experts during formative assessment activities. The former makes clear that the production processes build on assessment that is geared towards providing learners performance feedback in view of improving and accelerating learning (Sadler, 1998).

Motivational processes

Bandura (1986) makes a clear distinction between “acquisition” and “performance” because learners do not always demonstrate what they learned. This is especially the case when what is learned has little functional value or when weak performance results in negative reinforcement (Schunk, 2001a). Learners are more likely to perform what they have observed if it results in *valued* outcomes and if they *expect* to receive positive outcomes when performing demonstrated behaviour. This introduces in this context the need to define motivation. Linnenbrink and Pintrich (2002) subdivide the motivational constructs found in the literature into four families of motivational beliefs: self-efficacy, attributions, intrinsic motivation and goal orientations. Later, Pintrich (2003) expanded the four families with an additional construct: task-value. Below, the five constructs and their interrelationships will briefly be described.

Self-efficacy. Bandura (1997, p.3) did define self-efficacy as: “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments”.

Correlational and experimental studies demonstrate that learners with a positive self-efficacy are more likely to work harder, are more persistent, and attain higher achievement levels (Linnenbrink and Pintrich, 2002). A limited number of studies report negative effects of self-efficacy on performance, due to overconfidence (Vancouver, Thompson, Tischner, and Putka, 2002). Self-efficacy beliefs vary in level, strength, and generality (Pajares, 2002). Holladay and Quinoñes (2003) suggest that level and strength are a single factor in self-efficacy.

Bandura (1997) discerns four sources of self-efficacy. The first and most important source is *enactive* mastery experience. A successful performance generally raises self-efficacy and. It has to be stressed that the changes in self-efficacy are the result of active cognitive processing of the information about this performance. The cognitive processing encompasses the interpretation of personal factors like preconceptions about personal capabilities and perceived effort, and the interpretation of situational factors such as perceived task difficulty and aid received. The second source of self-efficacy is the *vicarious experience* or modelling. Since social comparison is important, models who share common attributes with observers, produce significantly greater gains in self-efficacy (Adams, 2004; Baldwin, 1992; Schunk, 2001a). Tucker and McCarthy (2001) report comparable results and argue that people observing successful peers, report subsequently higher self-efficacy levels. “Coping” models that overcome their initial difficulties exert a larger impact on self-efficacy than “expert” models that perform without any difficulty. Self-modelling is a special sort of modelling in which people observe their own successes (Bandura, 1997). Also self-modelling can enhance self-efficacy. The third source of self-efficacy is *verbal persuasion* and can be linked to giving feedback after performance. The fourth and last source of self-efficacy is the *physiological and affective state*. People develop for a higher self-efficacy level when they are calm.

Attribution. Attribution theory refers to the perceived causes for success or failure by learners. These perceived causes influence expectations about future success (Eccles and Wigfield, 2002). Three causal properties are distinguished: locus, stability, and controllability (Weiner, 2005). Locus refers to the location of the cause in or outside the learner. Stability is about the duration of a cause that can be constant or temporary. Controllability refers to a cause that is, or is not, subject to volition. Stability is linked to the anticipation of the same success or failure. Internal locus is related to feelings of pride and an internal cause that is perceived as controllable can generate feelings of guilt or shame (Weiner, 2005). Not only attributions by learners, but also attributions about causes presented by teachers, peers and others have an impact. Weiner (2005) indicates that intrapersonal and interpersonal attributes interact with each other and can result in paradoxical results.

Intrinsic motivation. Intrinsic motivation is the internal motivation to engage in an activity (Linnenbrink and Pintrich, 2002). The literature demonstrates that intrinsic motivation promotes to a higher extent learning and achievement as compared to extrinsic motivation (Pintrich and Schunk, 2002).

Goal. Goal constructs have been researched from two different perspectives, namely the goal content approaches and the goal orientations approach (Pintrich, 2003). We adopt the latter approach in this chapter. Goal orientations are defined as "…the reasons and purposes for approaching and engaging in achievement tasks" (Pintrich, 2003). In general, two goal orientations are distinguished: mastery (focused on learning and mastery of the content) and performance (focused on demonstrating ability) (Pintrich and Schunk, 2002). Recently, a second dimension has been added to goal-orientation through the introduction of a distinction between goal avoidance and goal approach (Schunk, Pintrich, and Meece, 2007). This second dimension is mostly used in conjunction with performance goals; though sometimes also with mastery goals. We build on the second dimension to differentiate between two types of performance goals: (1) approach performance goals where learners want to outperform others and demonstrate their competence, and (2) avoidance performance goals where learners want to avoid failure and looking incompetent (Schunk et al., 2007). Research has linked mastery goal orientations to positive cognitive, behavioural, and affective outcomes, avoid performance goal orientation to negative outcomes and approach performance goal orientation to mixed outcomes (Schunk et al., 2007). Kaplan, Middleton, Urdan, and Midgley (2002) suggest that learners can hold mastery and performance goals simultaneously and that low levels in both goal types produce negative outcomes. In contrast, high levels in both goal types could result in positive outcomes. Instructional design can support the goal-setting because learners tend to adopt goal orientations stressed in classroom settings (Schunk et al., 2007). Schunk (2001b) stresses in this context that research indicates that when people accept and commit themselves to assigned goals, they can be equally well motivating as self-set goals.

Task-value. The last construct, task-value, consists of four components (Eccles and Wigfield, 2002): attainment value (personal importance of doing well on the task), intrinsic value (similar to intrinsic motivation), utility value (how well a task relates to current and future goals), and cost (negative aspects of engaging in a task). Zusho, Pintrich, and Coppola

(2003) clearly point at the importance of relating instruction to the utility value part of task-value.

The five constructs, discussed above, are incorporated in the expectancy value theory (Bruinsma, 2004; Eccles and Wigfield 2002; Pintrich and De Groot 1990; Pintrich and Schunk, 2002; Schunk et al., 2007). Expectancy is related to the question ‘can I do this task’ and therefore linked to the self-efficacy construct. This is often influenced by a person’s attributions. The value component can be interpreted as an answer to the question ‘why am I doing this’ (Pintrich and De Groot, 1990) and deals with goals, intrinsic motivation, and perceived task value. It is important to notice that expectancy is not the same as self-efficacy because it is more future oriented, and influenced by self-efficacy and by goals (Schunk et al., 2007). Goals are seen as cognitive representations of *what* learners are striving for, next to goal orientations that indicate *why* learners are striving for something and *how* they engage themselves in this task (Schunk et al., 2007).

Sub-Processes in Self-Regulated Learning

Self-regulation can be defined as follows (Zimmerman, 2000, p.14) “self-regulation refers to self-generated thoughts, feelings, and actions that are planned and cyclically adapted tot the attainment of personal goals”. The triadic reciprocal causal model of human functioning (Bandura, 1997) considers learning outcomes to be the result of the interplay between instruction and self-regulatory mechanisms. Three mechanisms are distinguished: behavioural self-regulation, environmental self-regulation, and covert self-regulation (Zimmerman and Kitsantas, 2005).

The critical importance of self-regulation in the context of the social-cognitive approach towards learning requires a further analysis in view of the design and development of instructional interventions that foster self-regulation. In the following paragraphs, we describe (1) basic sub-processes of self-regulated learning, (2) the cyclic model of self regulated learning, and (3) finally the transition from observation to self-regulated performance.

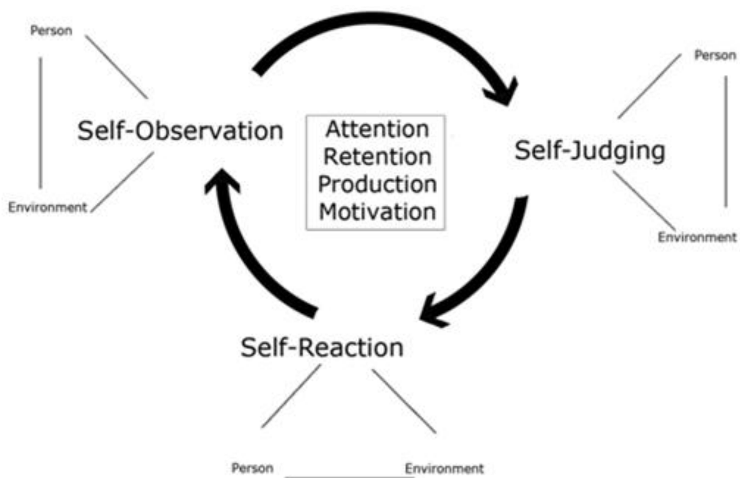

Figure 2. Basic sub-processes of self-regulated learning.

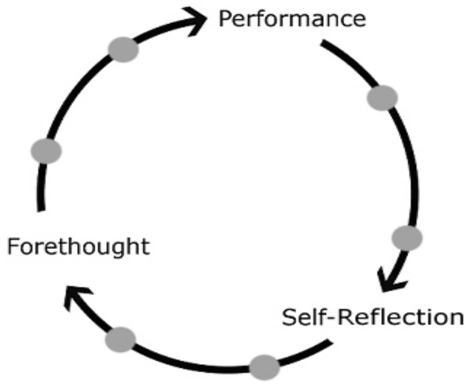

Figure 3. The self-regulation cycle (Adapted from Zimmerman, 2000).

Bandura (1986, 1991) and Schunk (2001a) distinguish between three basic sub-processes that underlie all subsequent processes in self-regulated learning: self-observation, self-judgment, and self-reaction. The interaction between these processes is depicted in figure 2. The representation also accentuates the reciprocal nature of the relationships between environmental factors, personal factors, and the three sub-processes. We also include the four constituent processes of the learning cycle.

Self-observation can be regarded as the first step in a learning process. It has, next to an informational, also a motivational function (Bandura, 1986; Schunk, 2001a). The information helps to set realistic performance standards and motivates learners to evolve depending on performance outcomes and efficacy expectations (Schunk, 2001a). Bandura (1991) warns in this context for inaccuracies in self-observation and the influence exerted by pre-existing self-conceptions and mood states. Schunk (2001a) points at regularity and proximity as important criteria for self-observation. Irregular observation and observation too long after the behaviour occurrence, can invoke misleading results.

The base for future behavioural change (or "better" performance) lies in *self-judgment processes* during which information gathered via self-observation is compared to a performance goal. This process is affected by the standards used, the goal properties, the importance of goal attainment, and success/failure attributions (Schunk. 2001a). Absolute standards are hardly available; therefore learners especially compare their performance with other learners or models (hence the importance of observational learning) and with previous performances (Bandura, 1986). Proximal, specific and moderately difficult goals offer the largest motivational benefit (Schunk et al., 2007), but it is the importance learners attach to the attainment of goals that will determine whether they assess personal performance (Bandura, 1991). If learners attribute failure/success to an internal cause they feel able to influence personally, the learner will start a *self-reaction process* that brings their behaviour in line with the performance standard.

We demonstrated the importance of goal characteristics in our own research (De Grez, Valcke, Roozen, 2009b). Students in a condition that fostered defining specific goals outperformed students in a condition where only a general goal had been presented (De Grez et al., 2009b).

The Cyclic Phases in Self-Regulation

In the former paragraphs, basic sub-processes of self-regulated learning have been described that play a role during each of the following phases: forethought, performance, and self-reflection (Zimmerman, 2000). This hypothetical cyclic model is represented in figure 3. Recent research presents a growing body of empirical evidence underpinning this model (Zimmerman, 2008). The model seems particularly suited to explain long-term learning processes (Zimmerman and Kitsantas, 2005), such as the learning of oral presentation skills. We added little grey circles within figure 3 that refer to the sub-processes of self-regulated as discussed above and depicted in figure 2.

The first phase is called the *forethought phase* that builds on task analysis and self-motivation beliefs (Zimmerman, 2000). Highly self-regulated learners have a high level of self-efficacy, of outcome expectations, of intrinsic interest, and of a mastery goal orientation. They break a task into subparts, set short-term, and long-term goals, and plan strategies to attain those goals (Zimmerman and Kitsantas, 2005).

The second phase is the *performance phase* that builds on the self-control processes and the self-observation processes described above; e.g., self-instruction, imagery, attention focus (Zimmerman, 2000).

The third phase is the *self-reflection phase* that builds especially on self-judgment and self-reaction. Two key forms of self-reaction have been studied to date: self-satisfaction and adaptive inferences (Zimmerman and Kitsantas, 2005). Self-satisfaction involves perceptions of satisfaction or dissatisfaction when performance is compared to standards. This perception also depends upon the intrinsic value of the task for the learner (Zimmerman, 2000). When its intrinsic value is low and a learner doesn't care very much about the task, than he/she will not experience high levels of (dis)satisfaction. Self-satisfaction directs future behaviour and creates motivators for this behaviour, because most people value self-satisfaction more highly than material rewards (Bandura, 1986). Adaptive or defensive inferences are the deductions about the need to alter one's self-regulatory approach (Zimmerman and Kitsantas, 2005). Learners make an adaptive inference when they choose a more effective strategy to attain their goal and a defensive inference when they decide to avoid the task in the future (Zimmerman, 2000). Zimmerman and Kitsantas (2005) state that learners who fail to set goals or choose a strategy during the forethought phase will end with reactive forms of performance and unsystematic self-evaluation.

Developmental Levels in Self-Regulation

The phases and cycles described above play a role during immediate and short-term phases in self regulated activities. What about the long-term development in self-regulation? The social cognitive perspective presents an iterative perspective (see figure 4) about the development of self-regulatory skills. We again introduced little grey circles into figure 4 to indicate that learners, at each developmental level, pass countless times through the cyclic phases of forethought, performance, and self-reflection that were depicted in figure 3.

The iterative process starts with social modelling experiences, and develops via emulation to a self-controlled, and finally to a fully self-regulated mastery level (Zimmerman, 2000). This process implies that the first level is an observational level requiring a learner to watch a model performing the skill to be acquired. When the learner tries – with assistance- to adopt the model behaviour, he moves to the emulation level. This does not mean that the learner copies the exact behaviour of the model but emulates the models' general pattern or style of functioning, also depending on a vicarious experience (Schunk and Zimmerman, 1997). Learning at the emulation level remains social, because performance is still enhanced by models that provide feedback and reinforcement (Zimmerman, 2000). At the third level - the self-controlled level - the learner practices the behaviour independently of the model, but still in a structured setting. The self-regulatory strategy is now internalized, but builds on the standards reflected in a model's performance (Schunk and Zimmerman, 1997). The self-regulated level is the fourth level where the learner is able to adapt his/her performance to changing conditions (Zimmerman, 2000).

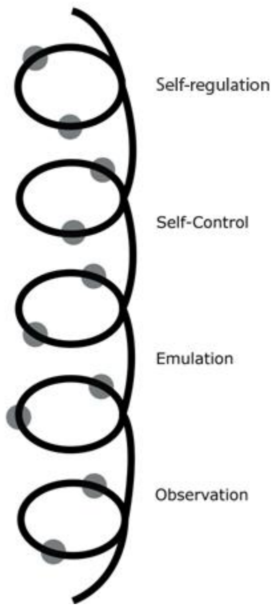

Figure 4. Developmental levels in self-regulation.

The developmental model assumes that learners will learn more easily and effectively when adopting the iterative process, but does not assume that every learner has to advance according to the specific sequence (Zimmerman and Kitsantas, 2005). Nevertheless, different authors present empirical evidence to validate the sequential validity of the developmental model (Zimmerman and Kitsantas, 1999, 2002).

Figure 5 offers an integrated graphical representation of the theoretical framework. The left side of the figure depicts the sub-processes that play a recurrent role during the cyclic phases presented in the middle of the figure. The right side of the figure portrays the long term developmental cycle from observation to self-regulation.

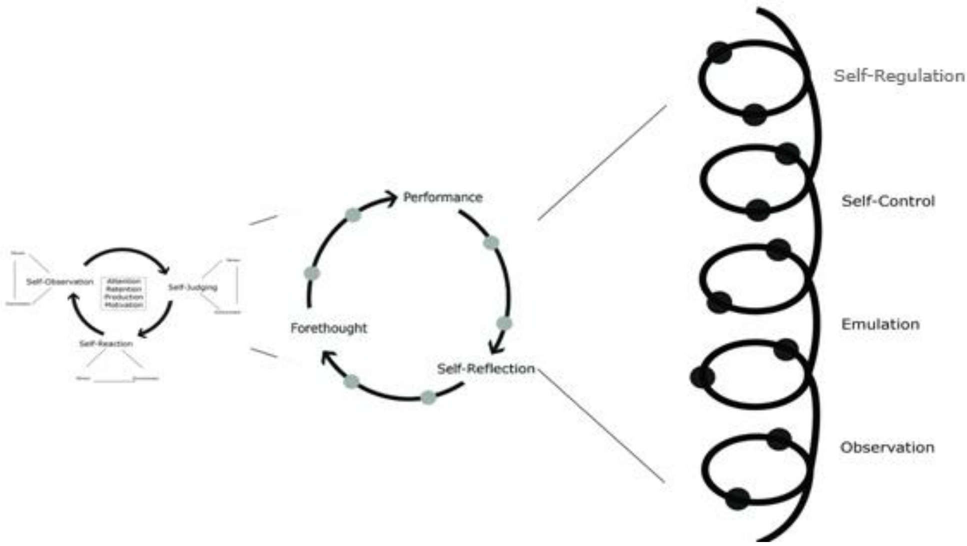

Figure 5. Schematic overview of processes involved in the social cognitive model of self-regulated learning.

CONCLUSIONS

A detailed elaboration of a general theoretical framework was presented in this chapter to guide the design and development of the instruction to develop oral presentation skills. A choice was made to adopt the social cognitive theory as a guiding theoretical framework. The framework builds first of all on cognitive as well as motivational variables and describes short-term as well as long-term features of the learning process. It also incorporates earlier research findings as much as possible and can inspire future research and guide instructional approaches. We can illustrate the latter with our own research (De Grez et al, 2009a). We developed a standardized multimedia instruction based on the theoretical framework where learners were invited to study in a standardized and completely autonomous way about oral presentations. Results confirmed that the instruction helped to foster the development of oral presentation skills in a significant way (De Grez et al, 2009a).

Developing oral presentation skills however proved to be the result of a complex interplay of cognitive and motivational processes. Many questions remain to be resolved but the researcher and the practitioner can start with a comprehensive theoretical framework to support learners to develop core competences that are central in many education curricula and are highly valued in the professional field.

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Chapter 5

BEGINNING ELEMENTARY TEACHERS' CURRICULUM DESIGN AND DEVELOPMENT OF PEDAGOGICAL DESIGN CAPACITY FOR SCIENCE TEACHING: A LONGITUDINAL STUDY

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ABSTRACT

Curriculum materials are critical tools with which teachers plan for and teach science. Rather than using them as written, however, teachers often evaluate and adapt curriculum materials. To effectively engage in this process of curriculum design, teachers need to develop robust pedagogical design capacity, or their ability to identify and mobilize requisite resources, both personal and material, to develop effective learning environments. However, beginning elementary teachers face many challenges in learning to engage in curriculum design for science. They often lack substantial subject matter knowledge, struggle to articulate scientific inquiry in practice, and experience teaching contexts in which science is deemphasized. These factors mediate teachers' interactions with curriculum materials. To explore how elementary teachers learn to engage in curriculum design for science, three beginning elementary teachers were studied longitudinally over their first three years of professional teaching. Results show that the three teachers engaged in a substantial degree of curriculum design, drawing on a myriad of curriculum materials and modifying them to craft their own science curriculum materials. Their curriculum design efforts were influenced by their own views of science teaching, but also by features of their unique curricular contexts. Ultimately, alignment between the teachers' views and the curriculum materials they used, as well as opportunities to engage in iterative cycles of curriculum design with a stable set of curriculum materials, were important in supporting their developing pedagogical design capacities. These findings have implications for the field's understanding of teacher learning along the teacher professional continuum and help inform research on teachers and teaching, as well as science teacher education and curriculum development.

INTRODUCTION

A consistent theme throughout the history of science education reform has been the preeminence of curriculum materials as a vector for change. Curriculum materials exert a direct influence on students' and teachers' day-to-day classroom activity and are therefore a commonly-used vehicle for efforts to change classroom practice (Brown, 2009). Recent research, however, suggests that science is emphasized less and less in the elementary curriculum (Appleton, 2003; Marx & Harris, 2006; Morton & Dalton, 2007; Spillane, Diamond, Walker, Halverson, & Jita, 2001). Furthermore, elementary teachers already face numerous challenges associated with science teaching, including insufficient subject matter knowledge (Abell, 2007), limited capacity to engage in standards-based science instruction (Smith & Gess-Newsome, 2004), and a lack of curricular resources necessary to support inquiry-oriented science teaching and learning (Appleton & Kindt, 2002). Elementary teachers need support to overcome these challenges. Science curriculum materials can serve as a valuable tool in supporting elementary teachers' science teaching. However, to promote teachers' capacity to use curriculum materials effectively, a better understanding of their interactions with curriculum materials is needed (Remillard, 2005).

In this study, we explore how three beginning elementary teachers' views of science teaching, as well as their unique curricular contexts, influence their use of science curriculum materials and how these interactions evolve over time. The research presented here adds to a growing body of educational research concerned with teachers' use of curriculum materials (Remillard, 2005). Thus far, this research has been focused largely on, for example, elementary teachers' use of mathematics curriculum materials (e.g., Lloyd, 1999; Remillard, 1999; Remillard & Bryans, 2004), middle and secondary science teachers' use of science curriculum materials (Enyedy & Goldberg, 2004; Fishman, Marx, Best, & Tal, 2003; Pintó, 2004; Schneider, Krajcik, & Blumenfeld, 2005; Roehrig, Kruse, & Kern, 2007), and preservice elementary teachers' use of science curriculum materials (Beyer & Davis, 2009-a, b; Davis, 2006; Forbes & Davis, 2008; Schwarz et al., 2008). This study addresses the relative dearth of research on beginning elementary teachers' use of curriculum materials (Valencia, Place, Martin, & Grossman, 2006), particularly those for elementary science (Forbes & Davis, in press), as well as the need for longitudinal research on beginning teachers' learning (Feiman-Nemser, 2001; Luft, 2007).

THEORETICAL FRAMEWORK

Science education reform of the past half-century has been influenced by two important components: the articulation of a *science curriculum* and the development of *science curriculum materials* to support teaching and learning of the science curriculum. We use *curriculum* (or *curriculum standards*) to refer to the standards, benchmarks, and outcomes that delineate the content to be taught and learned in science classrooms. We use the term *curriculum materials* to refer to textbooks, lesson plans, and other instructional artifacts oriented toward student achievement of curriculum-specific learning goals. Curricular resources including the science curriculum and curriculum materials play a crucial role in shaping science teaching and learning.

Unfortunately, extensive curriculum development efforts over the past several decades have done little to bring about sought-after reforms in science teaching and learning. Historically, teachers have often been viewed by curriculum developers as a delivery mechanism for curriculum content. We subscribe to an alternative perspective in which teachers act as co-developers of curriculum materials (Bolin, 1987; Clandinin & Connelly, 1998; Remillard, 2005). Teachers actively engage with the curriculum materials they use, interpreting, critiquing, selecting, and adapting (Barab & Luehmann, 2003, Enyedy & Goldberg, 2004; Pintó, 2004; Remillard, 2005). We use *curriculum design* to refer to these practices; in this study, the teachers mainly engaged in design of *curriculum materials*, having been provided with a *curriculum* that was used without much adaptation.

In their curriculum design, teachers draw on their knowledge and beliefs, professional identity, and orientations toward practice within unique professional contexts (Drake, Spillane, & Hufferd-Ackles, 2001; Enyedy, Goldberg, & Welsh, 2006; Pintó, 2004; Remillard, 2005; Roehrig et al., 2007). To engage in effective science teaching practice, teachers need a deep understanding of science subject matter and of how to teach science content effectively (pedagogical content knowledge), including specific instructional strategies, curriculum standards, and associated curriculum materials (Loughran, Mulhall, & Berry, 2004; Magnusson, Krajcik, & Borko, 1999). At the same time, teachers hold wide-ranging beliefs about, for example, teaching practice, subject matter, students and their ideas, the curriculum, teachers' professional roles and responsibilities, and the contexts in which they teach (Richardson, 1996). Teachers' beliefs can also have a critical influence on their teaching practice (Roehrig et al., 2007). We refer here to teachers' knowledge, beliefs, identities, and other expressed views as their *personal resources* (Brown, 2009). These personal resources are used by teachers as tools to engage in professional practice, including the use of curriculum materials. Here, we are most interested in aspects of the teachers' personal resources that relate to their *views of science teaching*—how central a role they see learning goals playing in guiding instruction; how teacher- or student-directed they see effective science teaching; the roles they see for inquiry, text, and investigations; and so forth (Davis, 2008). We use both *personal resources* and *views of science teaching* to refer to these perspectives.

Teachers' curriculum design is also mediated by particulars of their contexts, such as local standards and objectives, material resource availability, administrative support, and professional norms and expectations. Together with their personal resources and curricular resources, teachers' professional contexts contribute to their *pedagogical design capacity* (Brown, 2009), or their ability to identify and mobilize requisite resources, both personal and material, to develop effective learning environments. Our goal is to illuminate the ways in which beginning elementary teachers mobilize their personal resources to use science curriculum materials within particular contexts and how their pedagogical design capacity changes over time.

While teachers can leverage their pedagogical design capacity to use curriculum materials in productive ways, they may also do so in ways that are less effective (Pintó, 2004; Scheider et al., 2005). Even when teachers believe that they are using curriculum materials as intended, they often enact them differently (Bryan, 2003; Lloyd, 1999; Remillard & Bryans, 2004). Elementary teachers in particular may rely on a wide variety of engaging but conceptually disconnected 'activities that work' in science (Appleton, 2003). They may not view curriculum design as a part of their professional roles as teachers (Haney & McArthur, 2002; Southerland & Gess-Newsome, 1999). These issues are particularly prevalent for beginning teachers (Luft, 2007). Specifically, beginning elementary teachers often find themselves with insufficient curriculum materials even though they often rely heavily on them to structure and guide their teaching practice (Grossman & Thompson, 2008; Valencia et al., 2006).

The purpose of this research is to characterize the impact of teachers' personal resources and their unique contexts on their reported use of science curriculum materials and the development of their pedagogical design capacity over the first three years of their professional teaching careers. Two research questions guide this study. First, *how do beginning elementary teachers' unique personal resources influence their curriculum design over time?* Second, *how do teachers' curricular contexts mediate their curriculum design over time?*

METHODS

We studied three beginning elementary teachers longitudinally over the first three years of their professional teaching careers. These results are part of a larger longitudinal study of seven beginning elementary teachers begun in 2002 and undertaken to better understand beginning elementary teachers' knowledge and science teaching practice, particularly inquiry-oriented teaching, their use of science curriculum materials, and their professional learning (e.g., Beyer & Davis, 2008; Davis, 2008; Forbes & Davis, in press). The three teachers discussed here were chosen for focus because of their similar positions along the continuum of professional teaching and their unique school and curriculum contexts.

To support beginning elementary teachers' development of science teaching expertise and pedagogical design capacity, we developed a technology-mediated teacher learning environment called CASES (Davis, Smithey, & Petish, 2004; http://cases.soe.umich.edu). The learning environment, which is freely available online, provides inquiry-oriented science curriculum materials that are intended to be educative for these new elementary teachers (Ball & Cohen, 1996; Davis & Krajcik, 2005) and includes additional supports, including an online discussion space and reflective journaling tool. CASES is grounded in a model of scientific inquiry derived from that promoted by the National Research Council (2000); namely, the CASES curriculum materials emphasize asking and answering scientific questions, using evidence to support claims and thus construct scientific explanations, and communicating and justifying those explanations. Our use of *inquiry-oriented science teaching*, then, entails such practices. CASES curriculum materials provide rationales for pedagogical approaches and support teachers in adapting them in ways that reflect their unique teaching contexts. Such features help support beginning teachers by making innovative curriculum materials more flexibly adaptive (Barab & Luehmann, 2003; Fishman & Krajcik, 2003; Schwartz, Lin, Brophy, & Bransford, 1999). As a result, such curriculum materials are inherently more accessible and support teachers' learning in context (Putnam & Borko, 2000). The teachers in this study used CASES and its educative curriculum materials.

Participants

The three participants each graduated from an undergraduate elementary teacher education program at a large university in the United States. The summer after completing the program, each teacher obtained an elementary teaching position for the following year and was invited by the second author to participate in a multi-year longitudinal study. These teachers were contacted because, based on research group team members' relationships with them as students in science methods courses, they were interested in and likely to be reflective about their science teaching. The teachers volunteered to participate and were given the option of participating in the study to varying degrees; they each chose the most substantial level of participation. This involved teaching at least one CASES unit each year, maintaining a variety of records of science teaching practice, and participating in three annual interviews as described in the data collection section that follows. Their use of the CASES unit was important to the study to ensure that each teacher had at least some support for inquiry-oriented science teaching. None of the teachers used CASES curriculum materials to the exclusion of other curriculum materials; they drew on the CASES curriculum materials as one of many curricular resources. To better enable their use of CASES and communication with the research group, each teacher was provided a notebook computer early in the first year but did not receive any additional compensation over the course of the study. We use pseudonyms for the teachers.

Catie

Catie began teaching in the fall of 2002 and, throughout this study, taught in private Catholic elementary schools. During her first year, she taught sixth grade in a relatively small school in an affluent suburb of a major metropolitan area. She noted her students were predominantly Caucasian, class sizes were relatively small, and she taught science at least four days a week. She described her school as "more traditional than reformed" and, as a result, "the subjects that we teach…we try and be flexible and creative but a lot of it is basics. They really want basic stuff" (Catie, Int. 1.1, 114-118)[4]. While students in every grade level at her school were assessed in science annually, she had some freedom in choosing science content and designing instruction. During her first year, Catie had a full set of science textbooks from a major publisher. The textbooks included ideas for hands-on activities in the sidebars.

Between her first and second years, Catie accepted a new second-grade position in a much larger Catholic elementary school. While demographically and culturally similar, the nature of her professional role shifted dramatically. Her class sizes were larger and she began teaching roughly twice as many subjects, leaving little more than a few half-hour blocks each week for science instruction. She noted that when she was hired, the principal at her new school told her that their science instruction was very textbook-driven. In addition to receiving new science curriculum materials during her second year of teaching because of her move, she was provided another new set before her third year, because her school adopted new materials. Similar to those she used previously in her sixth grade teaching position, the science curriculum materials she used in years two and three were text-based materials from a

[4] Quotes from participant interviews are labeled as name [pseudonym], Int. [year.interview #], [line number(s) from transcribed document]

major textbook publisher. She also said that a disproportionate percentage of instructional time in her second grade classroom went to mathematics and reading.

Lisa

Lisa began teaching in the fall of 2002 and participated in our study for the first three years of her teaching, during which time she taught fourth grade at a small, socioeconomically heterogeneous and predominantly Caucasian public elementary school. She described her school as one in transition. Her principal, who had only been at the school a few years before Lisa arrived, was committed to innovative reform and had attempted to reconstruct the professional culture of the school. Lisa described the faculty as split between veteran teachers with many years of experience and beginning teachers.

Over these three years, Lisa taught science roughly four times a week. In her first and third year she switched classes with another fourth grade teacher and thus taught science twice per day. During her first two years, Lisa used a set of commercially-available science curriculum materials provided by her school. Instead of a single textbook, these materials were organized around separate topical texts. There were also comprehensive kit-based investigative materials associated with these texts—but no lesson plans. Between her second and third year, Lisa's school purchased new science curriculum materials for fourth grade.

Whitney

Whitney began teaching in the fall of 2002 and participated in our study for three years, her first three years of teaching. Throughout this time, Whitney taught fourth grade in a grade 4-8 public school that drew a very high population of military personnel and had a highly transient student and teacher population. Whitney assumed a number of leadership positions early on that would most often be reserved for more experienced teachers, such as mentoring a first-year teacher and becoming the grade-level chair at her school.

Whitney taught a wide variety of subjects. However, she taught the same six-week electricity and magnets unit six times each year. Whitney taught science, on average, two to three times a week for an hour and used kit-based science curriculum materials from a major curriculum developer. Whitney's school has relatively few resources and, as a result, many of her curriculum kits were consistently missing required resources.

Data Collection

We collected multiple forms of data. First, we interviewed each teacher three times annually for three years. These semi-structured interviews were designed to be approximately 45-60 minutes in length, though they often went substantially longer, and occurred once in the fall, winter, and end of the academic year. Each was administered over the phone by research group members, not the authors. The interview protocols were designed to provide the teachers an opportunity to describe their school settings, articulate their views of science teaching and use of science curriculum materials, and discuss their professional learning and development. During each interview, the teachers were specifically asked to describe planning for and enactment of science instruction, critique and suggest modifications for sample science lesson plans, and reflect on hypothetical classroom scenarios. Each interview was audio-recorded.

Two additional data sources, reflective journals and daily logs, were embedded features of CASES that the teachers used online. The reflective journaling tool is open-ended but provides scaffolding in the form of reflection prompts to promote productive reflection. The teachers were asked to complete at least one journal entry each week. They were also asked to complete daily logs for each CASES lesson they taught and were encouraged to complete them for most of their science instructional sequences. These daily logs included mostly forced response and multiple response type questions in which teachers characterized their instructional foci (e.g., topics and/or inquiry practices), activity structures (e.g., whole group discussion, small group work, teacher demonstrations, student investigations), and duration of instructional activities. The teachers varied considerably in how consistently they completed journal and daily log entries.

Data Analysis

Each of the audio-taped interviews was transcribed and all journal entries and daily log files were transformed into standard text documents. We employed thematic analysis to analyze the qualitative data. Because of their substantial depth and richness, and their alignment with our research questions which center on teachers' personal resources and curricular contexts, the formal interviews were foundational data sources that served as beginning points for analyses. The remaining data sources primarily served to further illuminate trends we identified, particularly as related to curriculum materials use and, in the absence of observational data, teachers' descriptions of their science instruction.

Table 1. Coding Scheme for Thematic Analysis

Code	Description
General Use of Science Curriculum Materials	
Design	Teachers' interactions with curriculum materials in absence of students
Construction	Teachers' interactions with curriculum materials in presence of students
Curriculum Mapping	Organization of the curriculum over time
Use of CASES Curriculum Materials	
Design	Teachers' interactions with CASES curriculum materials in absence of students
Construction	Teachers' interactions with CASES curriculum materials in presence of students
Curriculum Mapping	Organization of the CASES curriculum over time
Views on Science Teaching	Espoused views on science teaching and learning
Context	Relevant to teachers' use of curriculum materials – includes instructional time, opportunities for repeated enactment, prioritization of science teaching, availability of supporting resources, etc.

Analysis involved an iterative process of data coding, reduction, displaying, and verification of data (Miles & Huberman, 1994). We began data analysis by developing a coding scheme that was informed by current research on teachers and curriculum materials (Remillard, 2005) and dominant criteria relevant to inquiry-oriented science teaching as instantiated in the CASES curriculum materials and our own teaching and ongoing research efforts (Davis & Smithey, 2009). After developing and testing multiple related coding keys, we finalized an initial coding key that guided comprehensive analysis. As analysis progressed, additional codes were added to account for emergent themes related to these dominant categories. Table 1 provides the final coding key. As definitive patterns emerged from thematic coding, the data were reduced to isolate and illustrate key factors. This process continued until dominant themes had been refined and substantiated.

To enhance the validity of conclusions, we triangulated data between the interviews, reflective journals, and daily logs. The purpose of this was to challenge tentative claims generated from the interview data by searching for supporting and contrasting data and, thus to further elaborate the phenomena under study. For example, we draw on journal entries for further insight into teachers' views of and perceived challenges with science teaching, and we draw on daily log data to characterize differences in predominant activity structures used by teachers. Second, we sought to achieve a high level of inter-rater reliability. The first author coded 100% of the data. A second independent rater coded a subset of the data that was selected at random. The average inter-rater reliability was 90%. After discussion, 100% agreement was reached. Third, we compared our findings to other analyses of data from the larger longitudinal study (e.g., Beyer & Davis, 2008; Davis, 2008; Forbes & Davis, in press), looking for confirming and disconfirming evidence.

RESULTS

These three beginning elementary teachers engaged in substantial curriculum design, mobilizing and using a wide variety of curriculum materials for science teaching in light of their own views of science teaching and their curricular contexts. In answering our first research question, *how do beginning elementary teachers' unique personal resources influence their curriculum design over time?*, we found that the three teachers relied on science curriculum materials to structure their science teaching. However, each teacher found the curriculum materials they were provided by their schools to be insufficient given their views of effective science teaching. They reported mobilizing a variety of additional curriculum materials for science and adapting those curriculum materials in unique ways. In addressing our second research question, *how do teachers' curricular contexts mediate their curriculum design over time?,* we found that the stability of the teachers' curricular contexts, as well as their opportunities for iterative cycles of planning, enactment, and reflection, were important influences on their use of curriculum materials development of pedagogical design capacity. Overall, how they engaged in curriculum design for science teaching was a function of the teachers' views of science teaching—that is, their personal resources—and evolved over time as these views, as well as contextual factors, changed. We elaborate first on the influence of teachers' personal resources on their use of science curriculum materials.

Curriculum Materials Use and Influence of Personal Resources

Each teacher prioritized some version of authentic, active, standards-based (i.e., connected to national, state, or local standards or benchmarks), and reform- or inquiry-oriented science teaching and learning. This finding was not unexpected since each had taken the elementary science teaching methods course that emphasized these principles of effective science teaching. They each also came to view the mobilization and adaptation of external curriculum materials as a natural and essential aspect of effective science teaching. As Catie noted at the end of her first year,

> I can't say if there was one activity or experiment that I did this year that I wouldn't have some sort of modification to it. … (Catie, Int. 1.3, 684-688)

In engaging in such curriculum design, the teachers made principled decisions about how, what, and why to modify in preparation for and in response to enactment. The additional materials that they reported drawing upon were diverse and targeted at those aspects of their science curriculum materials that they perceived to be lacking.

However, the teachers navigated different paths through curriculum design. Catie and Lisa both used text-based science curriculum materials provided by their schools but were critical of these resources, especially during their first years. Over the course of the study, they integrated investigation-oriented science curriculum materials into the text-based curriculum materials they already had. In contrast, Whitney tried to use more text resources to supplement her investigation-oriented science kits. According to their daily logs across all three years, Catie and Lisa used text-based resources in 49% and 34% of their respective science lessons, whereas Whitney reported doing so only 9% of the time because, as she noted, "since I don't have textbooks, everything is hands-on, simple as that" (Whitney, Int. 1.3, 59-60).

We next describe the unique ways in which each teacher drew upon her personal resources—specifically, particular elements of her views of science teaching—as she used science curriculum materials.

How Lisa Drew upon Her Personal Resources in Curriculum Design

Lisa taught fourth grade in small public elementary school. In addition to having the science curriculum materials described previously, she also reported having a clear and explicit set of district-based, grade-specific learning goals for science (i.e., her science curriculum). For Lisa, the emphasis on specific goals for student learning became an important priority in her reflections on science teaching, and the belief in the centrality of learning goals served as a keystone of her personal resources. For example, she wrote in year one,

> There are so many aspects of a science concept that when teaching science you need to make sure you are narrowed in on what you want to teach. You cannot be too broad and try to

> fit everything in and believe that just by mentioning it you have covered it. (Lisa, Year 1 Journal, 3/3/2003, 16-20)[5]

Throughout the study, Lisa consistently reported tailoring her science instruction to particular district goals.

Not surprisingly, this attunement to learning goals served as an important influence on Lisa's reported use of science curriculum materials. Lisa's science curriculum materials included separate text resources for specific topics and associated materials (i.e., kits) to support student investigations. In discussing her school-provided science curriculum materials, she noted that "a lot of the kits are incomplete" and, because these materials did not include lesson plans for the teacher, she did not "know what the stuff in there is for" (Lisa, Int. 1.1, 89-106). She felt that they were not particularly well-suited to supporting her to address these goals and noted that "I haven't been using them that much" (Lisa, Int. 1.1, 88).

Lisa reported engaging in a highly design-oriented approach to instructional planning for science during her first year. When she was asked, for example, where she got most of the science curriculum materials she used, Lisa said, "I've had to make up a lot of my stuff on Saturday" (Lisa, Int. 1.1, 134-136). She noted that this involved drawing from a variety of what she considered to be high-quality science curriculum materials, particularly CASES materials, to supplement the curriculum materials she received from her school, saying, "I understand [CASES] because that's how I was taught how to do science units so it makes a lot of sense to me" (Lisa, Int. 1.1, 150-154). Lisa's emphasis on curricular objectives continued. For example, she said "I always have to think when I use CASES, because it's not specifically geared towards my curriculum …, 'does this fit?' or 'how can I just change it a little bit so that I can still use the lesson or use a part of the idea to make it fit more?'" (Lisa, Int. 2.2, 209-217). Her attunement to grade-specific learning goals influenced her use of multiple curriculum materials.

In fact, Lisa reported using her school-provided science curriculum materials in a limited way in her first year. Instead, she used the series of science lessons she developed. Throughout her first year, Lisa noted that "for every subject that I teach, I had a binder so throughout the year if I find something in a book about something, I just throw it in that binder" (Int. 2.1, 164-166). These teacher-constructed curriculum materials were important since they were, in Lisa's view, explicitly linked to the curriculum standards she was supposed to teach. For example, she discussed a magnets unit that she developed and enacted in her first year. In her second year, she was able to use these lessons again, saying,

> I went and got my binder that's full of my magnet stuff that I taught last year. I read through the unit that I did last year, and I looked to see what my line item for our report card was, and it just said the student can describe the properties of magnets …so then I went to my curriculum to look to see the objectives for magnets and from there, they were the same as last year so I just kind of read through the unit again. (Lisa, Int. 2.1, 117-136)

In the first two years of the study, Lisa reported developing multiple science units such as the magnets unit, drawing on the science curriculum materials she had at her school, but also additional material from external sources, including CASES. Her efforts doing so were most

[5] Quotes from participant journal entries are labeled name [pseudonym], Year [year] Journal, [date], [line number(s) from document]

prominently influenced by her school district's fourth-grade curricular objectives, which provided a concrete framework around which she oriented her curriculum design. Throughout the study, Lisa continued to prioritize curricular objectives in her use of curriculum materials. Thus, Lisa's main mediating personal resource—her view that science teaching and learning should be guided by learning goals—was complemented by an additional material resource—the curriculum that presented the learning goals on which her district wanted her to focus.

How Catie Drew upon Her Personal Resources in Curriculum Design

Like Lisa, Catie engaged in substantial curriculum design for science during her first year teaching sixth-grade at a private Catholic school. Catie was critical of the science textbooks she had at her school during her first year and, only a few months into that school year, like Lisa, reported that she had already quit using them (Catie, Int. 1.1). Also like Lisa, Catie began developing individual science lessons and comprehensive science units using a wide variety of external curriculum materials. She stated at the end of her first year that "I can't say that I've really been using lessons from any other place. I'm just kind of like creating what I think needs to be taught and pulling from different sources and making up my own lessons" (Catie, Int. 1.3, 320-323).

However, unlike Lisa, who emphasized learning goals, Catie emphasized inquiry-oriented and project-based science teaching in her use of science curriculum materials during her first year, and this aspect of her views of science teaching served as a critical mediating factor in her use of curriculum materials. For example, during her first year, Catie developed a science unit on water quality that she felt was engaging for her students since it revolved around a local lake. She described an extensive process of curriculum design:

> [It] wasn't anything that was given to me, I just kind of was going about it on my own without any resources, finding them as I went along. I found a couple lessons on precipitation, condensation, evaporation on the web. And then I just supplemented things. I found a video in our school library on water cycle and polluting water. … (Int. 1.1, 203-213)

This approach to science teaching—drawing on a range of resources to develop project-based science units—was a consistent theme in Catie's first year. She reflected on the motivating element of her design work, noting, "I did like going on my own, trying to figure out what I was going to teach, trying to make it more centered towards [students], giving them meaning in their own lives instead of just stuff coming out of a textbook" (Catie, Int. 1.1, 662-669).

Over the next two years, though, Catie began to move away from this project-based approach to science teaching. When she moved to a second grade classroom in a different school, she began to focus on providing students necessary structure, based on her assessment of their abilities and limitations. For example, during her second year, she modified a lesson from CASES modeling bird beaks to teach about natural selection. She had been working on "trying to get kids more involved in the scientific process" (Int. 2.1, 190-191) and saw the bird beaks lesson as an opportunity to provide additional structure and scaffolding. She noted that she revised the existing student worksheet, creating "individualized columns for each step" in an attempt to "break everything down" (Int. 2.1, 201-209). Catie justified the changes she made to the lesson based on her assessment of her young students' unique needs. She said,

> …for my second graders, and I think it's true for all young kids, structure and consistency is something that they need so much… so for this hands-on [activity], giving them that structure by going through each step and having something to do at each step really made it much smoother. (Int. 2.1, 212-217)

In much of her talk about her use of curriculum materials in her second and third years, Catie focused on adapting science lessons in ways that provided additional scaffolding for her second-grade students. This was particularly the case for collecting and organizing data and evidence from investigations, research, and teacher demonstrations.

Catie continued emphasizing this structure in her third year but also worked to provide students a wider variety of learning opportunities, not just investigations and projects. She said,

> I've kind of branched away my thinking, before I was thinking I have to be doing so many more experiments with them. Other kinds of activities, like a computer webquest, assembling a planet book, I think are good activities for the kids to gain knowledge just as much as experiments are. So I think that those are also effective ways of teaching science… just having a variety instead of like being read the text, do an experiment, read the text, do an experiment,… I think that gets dry too even though they're doing something hands-on. (Int. 3.1, 734-746)

Interactions between Catie's views of science teaching and her use of curriculum materials evolved dramatically over the course of the study. Initially, Catie believed strongly in project-based science, and engaged in significant curriculum design toward that end. In her second year, she added an idea to her views of science teaching about the importance of structure and support for students, and her curriculum design reflected this idea. Then, as Catie developed a belief that experiments and texts were insufficient, she began to draw on multiple resources to reflect her expanding values. Her shifting personal resources—most centrally her reduced emphasis on projects and investigation and increased emphasis on scaffolding—influenced how she drew on and adapted curriculum materials to design science instruction.

How Whitney Drew upon Her Personal Resources in Curriculum Design

Like Catie and Lisa, Whitney also drew upon a variety of curriculum materials to teach science in her fourth grade classroom. Unlike the other two teachers, however, Whitney was provided kit-based science curriculum materials by her school and used these as her primary curricular resource for science. In general, Whitney reported that she was satisfied with using her science kits and that they were generally consistent with her views on teaching science. Whitney used these same kits throughout the study.

Whitney maintained a highly student-centered view of science teaching, seeking to emphasize the role students can play in driving instruction. This belief served as the central feature in her constellation of personal resources that related to her use of curriculum materials. She articulated this early in the study, saying,

> I really think that you get the kids engaged in what they're learning about, it's really [important to] make it interesting for them, and also make it so that they retain the information. I think if you use some hands-on stuff and also discussions and things like that,

> where the kids can come up with answers, and the kids are guiding it, you know that they're understanding what's going on. And also, getting them to really probe into what you're doing. (Int. 1.1, 291-300)

Whitney described using questioning to scaffold her students' in-class activities and instructional strategies that allowed for ongoing informal assessment.

Whitney's student-centered views of science teaching were apparent in her talk about her use of science curriculum materials. In her first year, for example, Whitney used the electricity and magnets unit from CASES for the first time to supplement a unit from her science kit on the same topic. While each addressed similar scientific concepts, Whitney noted that they did so using different sequencing, saying "the CASES unit was designed backwards of what I did in the other units…my other unit started with magnets and CASES ended with magnets" (Whitney, Int. 1.3, 320). She wondered "how are you going to do electromagnets without magnets, right?" and, in the end, reorganized the CASES unit to be consistent with the organization of the magnets unit she had previously enacted. She noted she did so to build upon students' prior knowledge, saying, "it was something that they kind of knew about so it was nice to be able to start out with something that they kind of understood a little bit or had seen before" (Whitney, Int. 1.3, 303-325). In the end, while she incorporated the CASES lessons into her existing unit, consistent with her student-centered orientation, she retained the sequencing that she felt would make the material most accessible to her students.

Despite Whitney's satisfaction with her existing science curriculum materials and apparent success with supplementing them, her curriculum context differed significantly from Catie and Lisa's. While she too noted that she did not want to use a mainly text-oriented approach to science teaching, over time she acknowledged with increasing frequency that she would like to have a textbook to use in conjunction with her science kits. By the end of her first year, she was beginning to look for text-based content resources, writing,

> I also find it difficult at times to have only hands-on materials for science. I feel that textbooks with some information would help the students as well, as a reference as well as a starting point or a way to fill in the gaps of things we cannot experiment with in the classroom. (Whitney, Year 1 Journal, 5/16/2003, 11-15)

This feeling was exacerbated the following year with an experience enacting her electricity and magnets unit. Whitney recalled,

> If we were reading something, [the students would] say 'this isn't science, when are we doing science? Science is when we do stuff' … but they would just play around with the stuff and if I asked them about it the next day they didn't remember, so I was like I really need to incorporate more [subject matter text] right away. (Whitney, Int. 2.3, 1154-1180)

Having essentially no texts became a notable challenge. Whitney had stated early in her first year that her goals as an elementary science teacher were not only to make science enjoyable and engaging for her students, but also to promote learning. Whitney felt that this goal was not being met. As a result, she began to place increased emphasis on textbook use and its role enabling content-rich learning experiences.

Whitney's student-driven view of science teaching was an important factor in her use of science curriculum materials. In many ways this aspect of her personal resources was well-suited to the kit-based science curriculum materials she had been provided by her school. However, she also came to appreciate the limitations of her curriculum materials, and increasingly worked to incorporate more content-oriented text resources for the express purpose of supporting students' science learning. Thus, a shift in Whitney's personal resources—namely, her increasing awareness that students were not learning as much as she would like through her investigation-based science teaching—led directly to a shift in how Whitney used curricular resources.

SUMMARY

The three teachers did not perceive the materials they were provided by their schools to be sufficient on their own. Lisa adapted science curriculum materials, particularly investigations, to develop science lessons she felt best addressed district-specific learning goals, because of her belief in the centrality of learning goals. To engage in inquiry-oriented science teaching, Catie also drew upon a variety of science curriculum materials initially. Over time, however, she shifted away from this emphasis on project-based science to promoting student learning through a variety of types of highly scaffolded learning experiences. This was due, in part, to changes in her views of science teaching. Whitney selectively infused external science lessons in her kit-based curriculum materials and, as her own personal resources changed, she increasingly prioritized text-based content resources over time as a way to accomplish her goal of leveraging students' ideas to drive science instruction—thus maintaining her focus on student-centered science teaching and learning. In sum, the process of curriculum design became a function, in part, of each teacher's own views of effective science teaching.

Influence of Context on Teachers' Curriculum Design

We sought also to investigate how these teachers' curriculum design efforts were mediated by their curricular contexts. We asked: *How do teachers' curricular contexts mediate their curriculum design over time?* Features of these teachers' school settings, including the science curriculum and curriculum materials they had available and their relative stability, made up their curricular contexts. These features had a profound influence on the teachers' opportunities to engage in iterative cycles of curriculum design, enactment, and subsequent reflection, and thus also their development of pedagogical design capacity.

The three teachers experienced context-specific affordances and challenges specifically related to their use of science curriculum materials. For example, Catie had the opportunity in her first year to take full advantage of her enthusiasm for science and self-identification as an elementary science teacher. She believed that in this setting, the mandated science curriculum stressed fundamental concepts but was relatively flexible and not overly-prescriptive. For example, Catie said, "…it's not like in public schools where you could only teach something if it's in the standards. I can teach anything I want pretty much in science, which is good"

(Catie, Int. 1.1, 170-174). This allowed Catie to draw upon a myriad of science curriculum materials to create highly project-based, inquiry-oriented science units. Catie acknowledged that her curriculum design processes had facilitated her subject matter learning. She anticipated her pedagogical design capacity to continue to develop through ongoing cycles of curriculum design for science teaching (Catie, Int. 1.1, 586-615).

However, Catie received new school-provided science curriculum materials each year during the study. After moving to a new school and switching to a second grade teaching position after her first year, she found herself teaching a more highly-structured science curriculum, within a school culture where students had little experience with inquiry-oriented science teaching and learning, and where science was deemphasized in the elementary curriculum. She felt that much of the freedom she had experienced in her previous teaching position was missing in her new one and that she was always "trying to keep up with the other teachers" (Catie, Int. 2.2, 120-122). Catie struggled during her second and third year to negotiate her changing science curriculum materials, the pressure she felt to engage in science teaching that was consistent with her colleagues', and the expectations she had for her second-grade students. At the end of her third year she reflected on her developing capacity to engage in curriculum design for science teaching, saying,

> I feel like I really plan for stuff but then it doesn't go the way I want it to be and then everything else is thrown off. I feel like hopefully in a couple of years, maybe even at the end of the next year, I'll feel better about it. I'll know what to expect from the kids. I'll know what experiments are good and which ones aren't and… have kind of a better game plan. I guess is my overall goal is to get it so it's easier to plan… and get the materials together. (Catie, Int. 3.3, 970-989)

Even though Catie learned to use a wide variety of science curriculum materials to develop project-based science units during her first year, after that the demands of her new school and curricular context did not afford her the opportunity to build on previous curriculum design experiences. Instead, her curricular goals for science and her science curriculum materials, as well as her own views of science teaching, as described above, were in a constant state of flux. Though her early context afforded opportunities for design, she could not capitalize on these over time. As a result, by the end of the study, Catie remained in the early stages of developing her pedagogical design capacity for science teaching.

Lisa also struggled to use science curriculum materials to engage in the type of science teaching she envisioned. While Lisa prioritized learning goals in her use of science curriculum materials, she suggested that the way her curriculum standards were written encouraged traditional approaches to science teaching. She noted that she found it challenging to leverage her district's science curriculum standards to teach in ways that were consistent with her views of effective science teaching. She described many of her district-level standards as "basically memorization" and noted that it was "difficult to teach so that's why I did a lot of the stations and hands-on kind of stuff" (Lisa, Int. 1.3, 142-153). Lisa consistently worked to find ways to address her curriculum standards through inquiry-oriented teaching and found her existing science curriculum materials insufficient to do so. While she had the opportunity to teach the same content using the same science curriculum materials during her first two years, she still drew upon a significant number of external resources to develop the actual lesson plans she used.

During her third year, Lisa received new science curriculum materials and her district-provided curriculum standards changed. While she previously taught nine science units, the new curriculum standards only included five. These changes meant that some topics she had previously taught, including the magnets unit she had constructed and enacted in the previous two years, were no longer included in the fourth grade science curriculum. Furthermore, different topics had been added. While the increased depth and reduced breadth of topics enabled her to overcome some of the coverage issues she faced before (Lisa, Int. 1.3, 152), having new curriculum materials and topics she had never taught necessitated new approaches to curriculum design. Because Lisa was no longer teaching some of the same topics, the topic-specific pedagogical design capacity she had developed through curriculum design and enactment for particular topics, including her magnets unit, became less useful.

In contrast to Catie and Lisa, Whitney had many opportunities to teach the same electricity and magnets unit over the course of the study; she taught it multiple times each year. Iterative cycles of planning, enactment, and reflection provided opportunities for her development of pedagogical design capacity. In the spring of year two, Whitney wrote,

> As I think about what I am teaching in this unit over and over during the course of the school year, I noticed some key differences this year from last year. I am more prepared this year for each time, and I tend to adapt to the different cultures of the students as they come in. Last year I did the same things each time, and they worked well with some groups of students and not so well with others. This year, if something was not working, I would revisit the concept in a different way the next day and I was more flexible about things in the classroom. I think this may help my students learn the science concepts better… Also, by seeing what they wanted to know, I was more able to tailor the lessons to the classes. (Whitney, Year 2 Journal, 4/18/2004, 5-20)

Teaching the same unit multiple times each year for three years with essentially the same curriculum materials helped her develop what she perceived to be a more robust ability to use subject matter in effective ways to promote student learning. In assessing her own teaching during her third year, she noted that it was "better just because… I've gotten such a good knowledge base of electricity and magnets" (Whitney, Int. 3.1, 604-605). Her developing subject matter knowledge and pedagogical content knowledge became important tools in her increased attunement to leveraging students' ideas in her science teaching. She felt increasingly confident with her ability to effectively use subject matter she taught and noted the importance of past enactment experiences in helping her consider "what [content] I need to know, what [students] struggled with, and what I was confused about" (Whitney, Int. 2.3, 246-248). Teaching the same unit to so many different classes allowed her to develop a more experience-based understanding of how to make content accessible to students and how, in turn, students can guide her curriculum design, thus supporting her development of pedagogical design capacity.

Thus, the three teachers' use of science curriculum materials and development of pedagogical design capacity were tied to the contexts in which they took place. For Catie and Lisa, shifting curriculum materials and district-level science curriculum standards, as well as class size and the professional cultures of their schools, were strong influences on their use of science curriculum materials. Because of these shifting curricular contexts, both teachers were still working to develop curriculum materials for science that they felt were coherent with their views of science teaching, the needs of their students, and the demands of their classrooms. Whitney, on the other hand, had the opportunity to teach the same content repeatedly over the three years of the study. She was able to construct and refine units that she felt were congruent with her views of science teaching. That is, her curricular resources, personal resources, and curricular context were able to contribute synergistically to her pedagogical design capacity.

DISCUSSION

These findings add to two interrelated bodies of research concerned with teachers' use of science curriculum materials (Brown, 2009; Enyedy & Goldberg, 2004; Schneider et al., 2005; Roehrig et al., 2007) and teacher learning during the induction years (Feiman-Nemser, 2001; Luft, 2007; Putnam & Borko, 2000). Other researchers have described how teachers use curriculum materials, characterizing a continuum from faithful curriculum enactment to full improvisation (Brown, 2009; Remillard, 1999). These three teachers' interactions with science curriculum materials consistently fell towards the end of curriculum design spectrum characterized by invention (Remillard, 1999) or improvisation (Brown, 2009). In the process of improvising or inventing, the teachers mobilized a vast array of additional curriculum materials to construct their own classroom-specific instructional plans that guided their science teaching. Our findings extend previous research by illustrating how beginning elementary teachers engage in curriculum design using a variety of different science curriculum materials over time.

The teachers' reliance on science curriculum materials reinforces the importance of curriculum materials for new teachers (Grossman & Thompson, 2008). The curriculum design process, however, can be challenging for teachers, especially beginning teachers, and the quality of the adaptations they make to curriculum materials varies (e.g., Enyedy & Goldberg, 2004; Schneider & Krajcik, 2002; Pintó, 2004). The ways in which teachers adapt curriculum materials are mediated by their knowledge, beliefs, and other teacher characteristics, as well as their classroom contexts (Drake et al., 2001; Enyedy et al., 2006; Pintó, 2004; Remillard, 2005; Roehrig et al., 2007). While personally-developed or -refined curriculum materials may become more meaningful to the teachers themselves, this does not necessarily insure that they will be effective. This is the essential tension at the heart of curriculum development efforts: how to design curriculum materials such that promote particular learning experiences for students while simultaneously honoring teachers' capacity for curricular decision-making (Cohen & Ball, 1999; Davis & Krajcik, 2005; Fishman & Krajcik, 2003; Fishman et al., 2003).

The teachers here, however, described views about elementary science teaching that were relatively consistent with tenets of effective science teaching emphasized in science education reform (National Research Council, 1996; 2000). These teachers, to varying degrees, emphasized inquiry, investigations, learning goals, and student-centered science teaching. These are also principles of science teaching practice that we draw upon in the design of CASES and our teaching of the elementary science methods course in which the three teachers were previously students (Davis & Smithey, 2009). They worked to put these ideas into practice through their use of science curriculum materials. These results reinforce the important influence of teachers' personal resources, including their knowledge and beliefs, on their science teaching and also suggest that lessons learned in their teacher education program, particularly as related to inquiry-oriented science teaching, served as much more than a 'weak intervention' (Richardson, 1996).

The teachers' unique personal resources, then, did influence the teachers' use of curriculum materials, but presented less of an obstacle to their development of pedagogical design capacity than did, at least in Catie and Lisa's case, the professional contexts in which they worked. For these two teachers, particularly Catie, science teaching and learning occurred within a context of ongoing curricular change. The start of new school years brought entirely new sets of science curriculum materials or different grade-level science curriculum standards. Whitney, on the other hand, engaged in iterative cycles of curriculum design with the same curriculum materials each year. At the end of the study, she exhibited robust subject matter knowledge and knowledge of her students and her curriculum, each a key element of PCK (Magnusson et al., 1999). These findings suggest that effective appropriation and use of curriculum materials (Grossman, Smagorinsky, & Valencia, 1999) may require some degree of stability of curricular contexts. In other words, when teachers are able to use a select set of science curriculum materials as a foundation for their curriculum design efforts over multiple years, they may be better positioned to use curriculum materials effectively and develop pedagogical design capacity.

Our objective is not to paint a picture of new elementary teachers facing insurmountable obstacles at every turn. To the contrary, some of the features of these teachers' professional contexts, including strong curriculum standards and reform-oriented administrators, appeared to positively influence the teachers' development of pedagogical design capacity. The constraints, however, ultimately proved challenging to Catie and Lisa's professional growth. For teachers to learn to use curriculum materials effectively, they need alignment in their school settings. Discussions of teacher learning and appraisals of effective teaching should therefore be attuned to the same conditions of learning that are expected for students (Fenstermacher & Richardson, 2005).

LIMITATIONS

The objective of this study was to explore, longitudinally, how a few beginning teachers drew upon their personal resources—here, elements of their views of science teaching—within particular curricular contexts to evaluate, critique, and adapt science curriculum materials. This study draws on the teachers' own reports of their description, use, and adaptation of curriculum materials, rather than observational data of these artifacts and professional practices. Additionally, the three participants in this study were, in some ways, not typical elementary teachers. Most notably, they agreed to participate in a research study involving science teaching, a subject often not emphasized by elementary teachers or the elementary curriculum (Appleton, 2003; Marx & Harris, 2006; Morton & Dalton, 2007; Spillane et al., 2001). These limitations must be borne in mind when considering how one can warrant generalizations and determine implications of the work.

Because our research questions do not depend on the particulars of the curriculum materials themselves, or even the teachers' enactments of those materials, our use of the teachers' reports is warranted. A future study could quite fruitfully examine directly the artifacts and enactments, as well, and could extend the study to a larger number of more typical beginning elementary teachers.

While acknowledging these limitations and specifying what this study does not tell us about beginning elementary teachers' enactment of curriculum materials, our findings do illuminate factors that influence how beginning elementary teachers engage in a central aspect of their science teaching—namely, curriculum design. Especially for beginning teachers, for elementary teachers, and for the subject area of science, curriculum materials may play a pivotal role in shaping practice. Developing some insight into the factors that may mediate this aspect of professional teaching, even recognizing the necessary bounds on that insight, seems crucial as we work to better support these teachers who face so many challenges.

IMPLICATIONS

No matter how well-constructed science curriculum materials are, teachers who use them will modify them to some extent. The three teachers in this study drew on a wide variety of curriculum materials and resources and adapted them to their own teaching contexts. These results support the need for flexibly adaptive curricula that are educative for teachers and explicitly support this adaptation process. Since one goal of innovative science curriculum materials development is to promote reform-oriented science teaching, and because the modifications that teachers make are not always aligned with this goal (Schneider & Krajcik, 2002), supporting teachers through curriculum materials requires a careful balancing act between providing highly specified and developed curriculum materials and recognizing teachers' professional curricular decision-making (Cohen & Ball, 1999).

Educative curriculum materials, or those designed to explicitly support teachers' learning as well as student learning, can be valuable supports for teachers (Ball & Cohen, 1996; Davis & Krajcik, 2005), particularly beginning teachers (Beyer & Davis, 2009-a; Grossman & Thompson, 2008). The results presented here can help inform the field's understanding of educative curriculum materials design. Educative features that help make curriculum materials flexibly adaptive do so in part by making explicit the purpose of particular design features (Schwartz et al., 1999). These features should be lesson-specific and scaffold not only teachers' learning from the abstract to concrete, or instantiation of conceptual tools into practical tools, but also support teachers' generative learning and the construction of experience-based principles of practice—that is, of conceptual tools themselves (Beyer & Davis, in 2009-b; Davis & Krajcik, 2005; Grossman et al., 1999).

Using curriculum materials effectively is an important part of science teaching (Remillard, 2005; Smith, 1999). However, it is also challenging, and to better prepare beginning elementary teachers for these curriculum design challenges, teacher education should provide preservice teachers with ample opportunities to use curriculum materials in authentic ways. Science teacher educators can support preservice teachers' development of pedagogical design capacity by acknowledging their existing personal resources, leveraging these personal resources to develop requisite knowledge domains (Loughran et al. 2004; Magnusson et al., 1999), and helping them come to see the active use of curriculum materials as a fundamental aspect of their professional identities (Forbes & Davis, 2008). Beginning elementary teachers who are better able to align curriculum materials use with their views of effective science teaching may rely less on 'activities that work' (Appleton, 2003) and more on long-term, comprehensive, coherent science learning opportunities for students.

Given the importance of these three teachers' school settings in their use of science curriculum materials, it is necessary to consider ways in which to maximize those curricular context features that promoted the teachers' development of pedagogical design capacity and address those that did not. While Whitney benefited from her use of a select set of science curriculum materials to teach the same content over the course of the study, Catie and Lisa's changing curricular contexts proved challenging. While for Catie this was due in part to her decision to move schools, a common occurrence for new teachers (Ingersoll, 2001), it was also a function of curricular decision-making at the school and district level. A greater degree of stability would support beginning teachers in developing their pedagogical design capacity.

CONCLUSION

For teachers, especially beginning teachers, science curriculum materials will remain crucial tools they use when they engage in science teaching. Even for beginning teachers, curriculum materials use is an aspect of professional practice often characterized by a high level of curriculum design. As illustrated here, this process is highly influenced by teachers' personal resources as well as multiple features of their curricular contexts, including the stability of those contexts. While ongoing science curriculum development efforts will continue to produce curriculum materials that support teachers, it is imperative that schools foster the kind of contexts and professional culture in which such tools can be used effectively.

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Chapter 6

STUDENTS' IDENTITY CONSTRUCTION AND LEARNING. REASONS FOR DEVELOPING A LEARNING-CENTRED CURRICULUM IN HIGHER EDUCATION

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ABSTRACT

This chapter presents the results of a qualitative study conducted at Copenhagen Business School of the possible links between full time graduate students' identity and learning. Based on our empirical findings, we argue that students' learning is closely related to their identity construction processes. We also argue that since there is diversity in terms of students' identity construction and students' approaches to learning, curricula should be developed to fit the individual learning needs of students. As such the chapter presents a move towards student- and learning centered curriculum development and it aims to inspire faculty and administration within higher education institutions to systematically address issues of identity and learning in their educational programs. The underlying argument is that such focus will help enhance students' learning outcomes and at the same time help them in their creation of professional identities. The chapter will be of interest to curriculum developers, administrators of higher education, and teaching faculty interested in improving students' learning outcomes.

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INTRODUCTION

We are particularly interested in students' engagement in learning and its relation to their creation of professional identities. We argue that identity and learning are closely related, and that the success of higher education depends on the ability of faculty and administration to systematically address issues of identity and learning in their educational programs. When we speak of "success of higher education" we address two aspects: 1) improved student learning outcomes; and 2) creation of professional identities. Our arguments are first and foremost based on our analysis of empirical data from four explorative focus group interviews we carried out with first year graduate students from different educational programs at Copenhagen Business School (CBS). Secondly it is supported by references to theoretical frameworks and existing empirical research on learning and identity.

The chapter is divided into three main sections. First we present our views on identity and learning to conceptually explain why we link together those aspects. Second we report from our qualitative study to show the ways in which our students conceptualise identity and learning. Third we look at the implications for curriculum development.

Section 1: Identity and Learning

Within research on organisations (Brown and Starkey, 2000; Rothman and Friedman, 2001; Child and Heavens, 2001) and workplace learning (Kirpal, Brown & Dif 2007; Cohen 2003) an increasing number of recent studies show a link between identity and learning. The black-box view of organisations as effective machines in which employees operate according to the plan (Taylor, 1911; Fayol, 1916), which Scott (1991) labels as a rational and closed view on organisations has long been abandoned. Organisations are rather seen as natural and open systems (Scott, 1991), where values, norms, and institutions affect the social construction of realities and relations. Here employees create meaning of themselves, others, and present situations based on their past experiences and future expectations. We subscribe to these views on organisations and employees and argue that just as employees' identity and learning are related, such are students'. In relation to identity and learning there is no evidence that the underlying mechanisms governing their relationships should be different for students than for employees. Hence, in order to develop successful curricula where students' enhance their learning outcomes and create a professional identity we need to systematically address issues of identity and learning in our educational programs. Now, more specifically, what is identity and learning, how are they related, and how is it possible to include them in the curriculum.

Why identity matters

Hall (1968:447) defines identity as "the individual's perception of himself as he relates to his environment". As a conceptual term, identity is often divided into two broad categories: 1) personal identity and 2) social identity. The personal identity resembles what Miller (1963) defined as "core identity", which is a kind of primary self. The social identity resembles what Jung (1953) defined as "persona" and Goffman (1953) defined as "face-work", which is that of our identity which is exhibited to the world around us. In this article we substitute social identity with professional identity as we argue that university students are studying to get a recognised degree, which can lead to a professional career. Although closely related to the individual, identity is not an individual product. Identity creation is a social process and identity stems from social relations. Identity is neither some primordial core of personality that already exists in the individual (Wenger, 1998), nor something we switch on and off. According to Goffman (1959, 1961) individuals construct their identities with the purpose of managing impressions during everyday life performances, and to obtain strategic resources from their interactions with others. Stone (1962) points at the importance of appearance, discourse and meaning in the interaction of the individual within society. Identity is not objective, but fragmented, multiple and dynamic as it is derived from our relations with the world around us. As individuals we develop our identity in interaction with the social context we participate in. Hall (1968) writes that identity creation is a transitional process conceptualized as a series of boundary passages from one role to another. Identity creation thus is a constant and open-ended process of identification, belonging and positioning oneself in different contexts taking different roles. Roles that many would be familiar with, would be roles as primary school pupils, college students, university students, employee, brother, sister, wife, husband, or parent. Identity swings between the different roles, thus identity is not fixed. It is deconstructed and reconstructed over time, both tacitly and implicitly. Our identity construction directs the ways in which we make sense of the word around us, because we express different interests and have different points of attention due to our experiences and the roles we have had and presently have. Due to the rapid change and discontinuity that are prevailing features in our world, people face many different contexts and are part of many groups and interactions during their everyday life. The different frames in which we take part during our daily lives have codes of behaviour, co-opted patterns that define the expected and the out-of-frame behaviours (Morean, 2005). We act in these frames together with other individuals, maintaining with them a relation of trust that allows us to have a membership feeling, which is an active part of our identity creation.

If these arguments of identity and identity creation are taken into account, it becomes clear that identity matters when dealing with curriculum development in higher education. It does so because students take on roles which are defined in relation to their past experience, current sensemaking (Weick, 1979), expectations about their future, affected by the context in which they are embedded. Students', by logical inference, cannot be seen as a homogeneous mass with identical identities, but are to be seen as heterogeneous individuals with heterogeneous identity projects. In order for them to be able to create matching personal- and professional identities, the curriculum needs to take into account their identity creation processes. We will return to the issues of curriculum development in section three of the article.

Why learning matters

It is commonly accepted that the contextual relations of the learner affect his or her learning process (Bandura, 1975; Kolb, 1984; Vygotski, 1987; Lave & Wenger, 1991; Wenger, 1998; Bruner, 1998; Nygaard et al., 2008; Nygaard & Holtham, 2008; Nygaard et al., 2009). Hence, learning is a collective process rather than an individual psychological process, where knowledge is anchored in and created from collective practice and collective institutions. As such knowledge is not an objective object which can be transferred across independent persons or contexts. Knowledge needs to be actively created by persons taking into account their past experience and future expectations. To make sense of individual learning processes it is vital to understand the circumstances and contexts for learning. Just as identity is affected by context, so is learning. Learning takes place (knowledge is created) as a contextual endeavour. Within these recent traditions learning (and knowledge creation) is seen as an embedded process being affected by both the learners' identity (Bramming, 2001; Greenwood, 1994; Wenger, 1998) and social position (Lawson, 2001) in ongoing systems of social relations (Granovetter, 1992).

Moreover, there is empirical evidence that students have different approaches to learning, as well as different motivations. Marton and Säljö (1976) developed the concepts of deep and surface learning. Marton conducted a research project at Gothenburg University and looked at how students approached the reading of academic articles. The results defined four types of responses to learning: passive and active deep learning, and passive and active surface learning. The students that have an approach to learning characterized by deep learning would from the beginning try to understand the meaning, interact actively with the arguments of the author relating them to previous knowledge and their own experience, and try to determine the extent of the evidence presented in the author's conclusions. On the other hand, a student with a surface approach to learning, has as an intention the reproduction of knowledge, and will use as a strategy the memorizing of what she/he considers important with the objective to answer questions about it. This second approach to learning is much task oriented and constraint by it.

Content wise, learning is different too as argued by Ausudel (1968). He stated that there are two main types of content in learning, being meaningful learning and rote learning. In that sense, when what is to learn is highly mechanical and not meaningful, the student will take a surface approach that permits the memorization of the content and will avoid a deeper use of cognition. When the content of learning makes sense when interiorizing it, so that understanding it makes it easier to process it, the student will adopt a deep learning approach.

Vermunt (2005) acknowledges the importance of the orientation of the individual to learn in relation to the learning approach and learning outcomes. He distinguishes 4 distinct orientations to learn: vocational, which is oriented to obtaining a degree and obtaining knowledge to apply on the future career; personal, which is concerned with personal self-fulfilment and taking new challenges and insights for personal development; academic, which is related to progression in the academic ladder and in obtaining knowledge for knowledge sake; and social, which is oriented to have a good time and broaden social networks and is materialized with the use of campus facilities and engagement in social activities.

If these arguments about learning are taken into account, they too have an important saying when dealing with curriculum development in higher education. Learning cannot be delivered in a one-way communication process, but need to be actively taken by the learner, and this is subject to the learner's identity and context. Students are heterogeneous in the way they approach learning, being surface or deep approaches, and the nature of knowledge that is relevant for the different studies is different in content, being rote or meaningful. Students have different orientations to engage in learning, which need to be understood individually, or at least, the curriculum has to contain the space for directing ones orientations.

We will return to the issues of curriculum development in section three of the article. In the following section two we will look at the results from our qualitative study of students' identification of and thoughts about identity (social identity and professional identity) and learning. Section 2 thus provides empirical data supporting the theoretical arguments about the relationships between identity and learning.

Section 2: International Students' Identity Construction and Learning

The data presented here comes from four qualitative focus group interviews conducted from December 2008 to April 2009. 34 students participated. They came from: Scandinavia (8), Eastern Europe and Russia (11), rest of Europe (8), America (4) and Asia (3). Three of the focus group interviews were conducted with international students only, and one focus group interview was conducted with Danish students only. We choose a Danish group only for our 3rd focus group interview as a control group, because we were interested in knowing if international students experienced identity and learning issues differently than the native Danish students.

Although all students for each focus group were present in the same physical location during the respective focus group interviews, we used a weblog on the Internet to carry out and document the focus group interviews. Students were asked three questions, which they could answer online. The questions were as follows:

1. In what ways does studying at CBS affect you as person?
2. How would you define learning? Give an example of a situation at CBS where you learned something and compare it with learning processes in other studies or countries.
3. How has your identity and your learning (both content and processes) evolved or changed at CBS? What are you influenced by when you decide how to learn?

Question 1 was asked to get the students to share their thoughts about their personal identity. We were particularly interested in knowing whether studying at CBS changed the ways in which they looked upon themselves as persons. In other words, if context had an impact on personal identity creation.

Question 2 was asked to get the students to share their thoughts on learning. We were particularly interested in knowing if studying at CBS led to a particular understanding of learning.

Question 3 was asked to get the students to share their thoughts on their professional identity. We were particularly interested in knowing if, and if so at what time, students would experience a professional identity. We were also keen to know if this professional identity had any impact on their understanding of and approach to learning.

As it appears, questions were asked using an everyday language and not a theoretical language. This was a choice made in order not to constrain and structure the answers of students. Focus group interviewing has such limitations regarding link of data and theory and problems of bias. However, it also has benefits as it gives rich and personal accounts of the respondents (Morgan, 1988). Furthermore, as our focus group interviews were conducted on a webblog, all students could answer the questions on their own, immediately see the answers of others, and then choose to debate the answers of others by leaving comments or proposing new questions in relation hereto. The focus group interviews then evolved as personal, written dialogues about the subjects rose in the three questions. As researchers we both participated in all four focus group interviews and took the role of facilitating the dialogues by asking in-depth questions and asking for clarifications. All our questions were visible to all students too. Technically speaking each answer or question from students and researchers were posted as a comment on the webblog. In total we got 687 comments from the four focus group interviews. They were distributed as shown in the table below.

Figure 1 shows a sample from the weblog to show how students were writing in an ongoing dialogue. Here it is taken from focus group 4's answers to question 2.

Table 1. Distribution of comments during the four focus group interviews

	Question 1	Question 2	Question 3	Total
Focus Group 1: International students	53	48	84	185
Focus Group 2: International students	41	47	39	127
Focus Group 3: Danish students	68	62	62	192
Focus Group 4: International students	45	84	54	183
Total	207	241	239	687

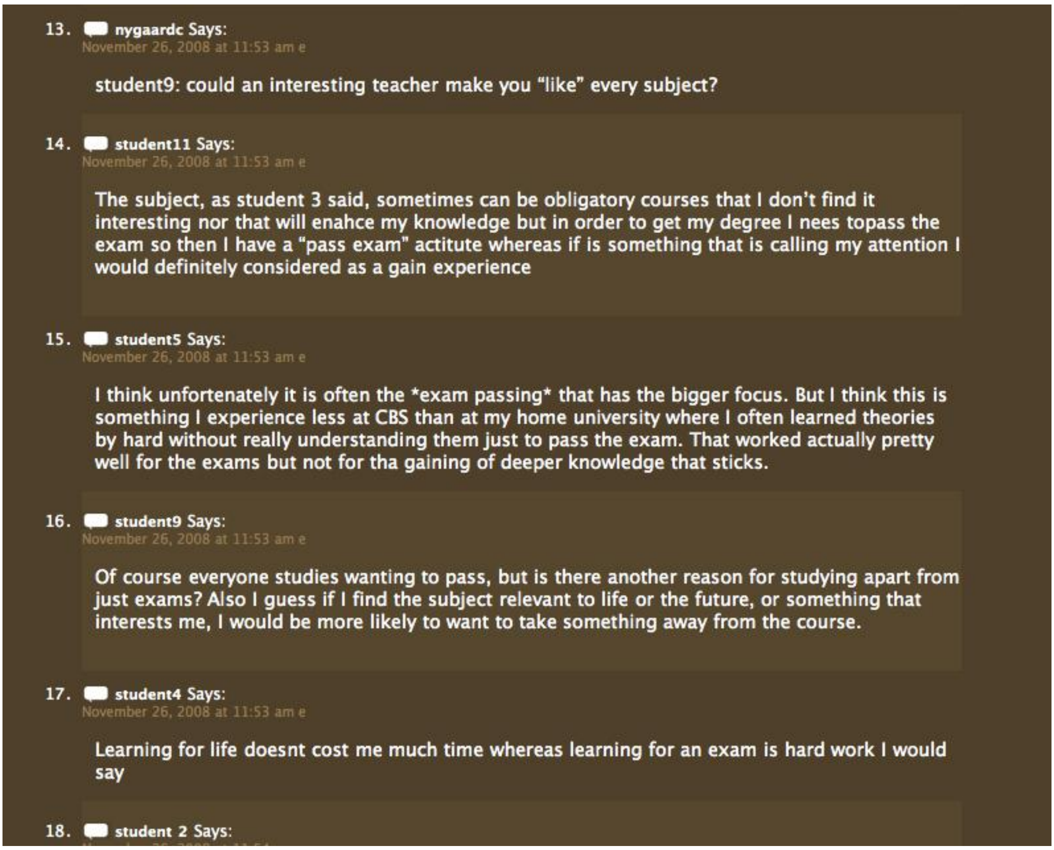

Figure 1. Sample from the webblog. Focus Group 1, Question 3.

In the following sections we take a closer look at the replies given to the three questions, and we analyse them in relation to our theoretical understanding of identity and learning. For this article our analysis is concentrated on the international students participating in focus group interviews 1, 2 and 4. Following this analysis we move to section 3 of the article, to discuss the implication for curriculum development.

The impact of the context on personal identity (Question 1)

International first year graduate students experiment a discontinuity (Scanlon et al., 2007) in their personal identity when they arrive in Denmark. They change their physical setting, and transform from old to new social communities. Students that study abroad experiment a change within their social life, which affects their personal identity. Moreover, students expressed difficulties to get to know their Danes co students. Even though Danes and internationals share classes and the different campuses, interaction is not that common, so the international students relate more to each other than to Danish students. This is stated in the research from Ujitani and Volet (2008), where the lack of interaction is caused by a lack of cultural understanding or as they call it, by socio-emotional challenges.

> As an international student studying at CBS that means that I have to start building personal relations with new friends. That poses a challenge too. (St2, focus1)

> I would definitely agree to what student 2 says. Especially with regards to becoming friends with Danes. Coming here as an international fulltime student is quite challenging. You don't belong to the 24/7 exchange student party scene and at the same time it is difficult to become friends with Danes as most of them already have their stable set of friends and assume you are going to leave again after 2 years anyways. (St3, focus1)

> Living in Denmark also poses challenges of its own, since there is a different perception, but having an international mindset always helps to overcome barriers and see things from a different perspective. Finally, CBS is really international with a large network of corporate partners, thus, it is very competitive in Europe. As I was talking to my friends, I told them about the competitiveness of the Danish education system, its flexibility, and most importantly, the opportunities that it offers to international students. (St12, focus2)

> …in the beginning I was in panic about the schedules and buildings so that I felt so small and lost, but that's was in addition to the shock to come and understand where I am and what is this country. So personally I had to reconstruct understanding about the rules, the way of doing in school… Now I am fine, two years later, after having been on exchange and switched to regular student, I feel like I know what's going on in class but still I learned that the exam process is a very random one and even if there are some rules it is a complete surprise each time how I will perform, a Russian roulette heeh (St19, focus4)

Students valued very positively the fact of having an international mindset, also as a way to react to the challenges that being aboard poses.

> …studying in international environment makes you better in understanding people because of different cultures. You get used to different things and perceive them as a

consequence of different cultures, while before that might had been a misunderstanding and mis-tolerating people. So attitude changes. (St24, focus 4).

In my opinion studying at CBS enhance my openess towards other people since it is a very international school. (St2, focus1).

Within this context, students search for a feeling of belonging to a group that legitimises their everyday life practices. Most of the students agreed that there is a difference between Danish students, short time exchange students and international full-time students. The five students, who had attended a short time Erasmus programme at CBS before enrolling in the full-time graduate program, acknowledged that there were different expectations and perceptions for the different experiences. International full time students tend to embrace more the Danish culture than the short time exchange students. Many of the full-time students interviewed were attending additional Danish language classes and had intentions to stay in Denmark after their programme.

I have also met a lot of people that I find quite similar to myself, which in a way verifies my own identity. I feel I am at the right place at the right time, with the right people and that gives me confidence. (St22, focus4).

I also experienced the time as an exchange student at CBS and the relationships to Danes different as I do now but still it seems to be complicated to get closer to them. The international students left their home countries and that means family, friends and stable social environments. We are searching for new relationship circles here and that seems to frighten some Danish students as I heard from the personal (St4, focus1).

As I was an exchange student here I also took the Danish crash course week but didn't participate on the Danish classes in the following semester. It was not because I don't wanted to integrate myself deeper into the Danish language, it was more because the whole situation was new to me to study abroad and I wanted to focus on the more relevant lectures. Now that I decided to stay at least two years here I am fully encouraged to spend tremendous hours on my integration in Denmark. I really enjoy it (St16, focus2).

All of the international students interviewed except one (25/26) answered that their main reason for coming to Denmark was to study at CBS. Only 6/26 acknowledged other reasons influencing their decision, like having a Danish partner or coming especially because they liked the city of Copenhagen. Many of the students interviewed attributed an important role to their decision to study at CBS to CBS' reputation in the business world. Students believed that their experiences at CBS would make them "gain face", which is explained as prestige and success in their future work life. This corresponds also with a vocational orientation to learn. Several students talk about the importance of the family in legitimating their decisions, in backing up their experience. Moreover, studying a graduate programme was attributed with a positive change of social position.

(...) that I am able to study at a business school as CBS. Having lived abroad for a while already this is nothing new to me. Being able to tell my family, relatives and friends what I am able to achieve by following a masters at CBS counts for me more. It's about increasing my

> horizon, not sticking to one place and mindset and getting to know how other people think, act or behave first hand. (St17, Focus2)

> For me it is quite important when telling people or companies back home that I'm studying at CBS because it is a well-regarded business school with a more international perspective than the business schools back home. This automatically reflects that it is a more international community. (St15, Focus2)

> I would say that in the workplace, you definitely get a higher status if you have a graduate degree, and that translates into more responsibility and higher salary, in addition to the respect you get from your co-workers. Family wise, I come from a family of teachers and scientists with PhDs, PhD is like a family tradition, so they are happy that I am doing a graduate study, but they did not push me to do so, so I do not think my family was a factor. (St18, focus4)

> In my family, grades of the chosen university degree are important as they were always a good indicator of how successful my family members were in their future jobs. (st26, focus4)

Family is an importance factor in the creation of personal identity, and so are fellow students. At CBS group work is very common in most of the programmes. In the international programs, group work benefits are complemented with cultural benefits. Most of the students highlighted the impact that group work has on their personal identity creation.

> Study groups with people of different cultural background - that is a challenge each time we have to cooperate. I learn to seek for compromises. (St13, focus2).

> I think having group work is very good because then you increase your skills as a team member and learn how to work with different people, and of course when you are discussing things in group you better analyze the problems and things because you get different ideas than yours (St24, focus4).

Generally speaking, the CBS pedagogy, what has also been referred to as Problem Oriented Project Work (Meier & Nygaard, 2008), also affects the personal identity of international students. They are working much from a pedagogy that centres the students' learning process and give students' responsibility to take control for their own learning process.

> I think it makes me more aware of myself. In class you are asked to have your own opinion, so you need to think about your own opinion a lot. It also gives you the possibility to open your horizon on a more personal level, because you have such an international experience. (St5, Focus1).

> CBS effects me in many different ways, the way courses are build up is different to my home country and comittment is much more expected then I experienced before. At CBS I have the feeling as my opinion would really matter to the course content. (St4, Focus1).

In sum, 1st year students experience an identity discontinuity, they stop being in contact with their previous social groups, family and national "rules of the game". When they arrive at CBS, they find out that they are not included in the dominant group, and they look for legitimity in students who share the international experience. Having an international mind-set hepls them adapt to their new reality and paliates the negative effect of not belonging to the national culture. Students moved ot Denmark mostly to study as their first reason, and attirbute a social status to study a graduate programme, both in terms of future job opportunities and international experience. The CBS pedagology, POPW, is seen as a positive element that has an impact in their personal identity, since it shapes interaction and unerstanding between fellow students. All in all, context affects highly the students.

The Nature of learning (Question 2)

Our research gave us evidence that the individual students perceive very differently learning. We asked for a definition of learning, and those were quite different between each other. We believe that the different experiences of the individuals, materialized in their identity project and together with their different expectations and orientations to learn, are the cause for this diversity. We classified the different definitions following two axes: one for the nature of knowledge that is learned (practice oriented- academic oriented) and one that focuses in the actors involved (exchange- personal process). These dimensions were significant both because they emerged from the students' definitions and because of their relation to curriculum development.

Exchange process: Students give an important role to the social world around them, e.g. professors and fellow students, which develop a fundamental role in their learning process.

St10: Learning as an exchange game: teacher puts down knowledge, and the student puts down the effort to understand and give feedback.

St7 : Learning: an interactive process: exchange of ideas and knowledge under the guidance of a teaching person. An example would be a random lecture from this term.

St11: A double way process, where there's the provider of the information and there's the receiver.

St4: Learning to me is an interactive exchange of knowledge, experience and having the will to learn.

St8: A dynamic process between several parts where one exchange some sort of information in order to solve a problem or reflect on a certain topic.

St22: Learning is an ongoing process where different parts exchange different information.

St2: I would say that learning is a process where you acquire knowledge from different sources and make use of it.

St15: Is when you participate and have discussions and not only sitting in a lecture listening to what the professor. says. At the time the professor has to transfer theory into real life scenarios.

Practice-based knowledge: Students acknowledge the instrumentalism of learning, for practice.

St18: I define learning as obtaining knowledge, either tacit or explicit, that I can apply to practice. So that is why I need both the what and the how, theory and practice, to go together.

St25: Learning is to absorb a subject and use the new information to then do something for the first time or to do it better.

St33: Being able to apply an experience.

Personal experience: We consider that most of those definitions are focused on the individual process one makes when learning. We find it consistent with deep learning, for there is personal engagement.

St19: Learning for me is understand something more about the what's going on around in the business, social universe and in the same time understand something more about who u are. The both processes are interlinked, otherwise it is not learning but just acknowledging and forgetting. Learning is a long term process, as long as your life and so that the academic learning experience is an aspect of it, not an end.

St16: is when I start to think about a subject within my own perspectives and try to work around in my mind.

St13: Learning at CBS means studying (by myself, not taking the knowledge directly).

St20: I define learning by a change, either in my knowledge, skills or the way I act in my life.

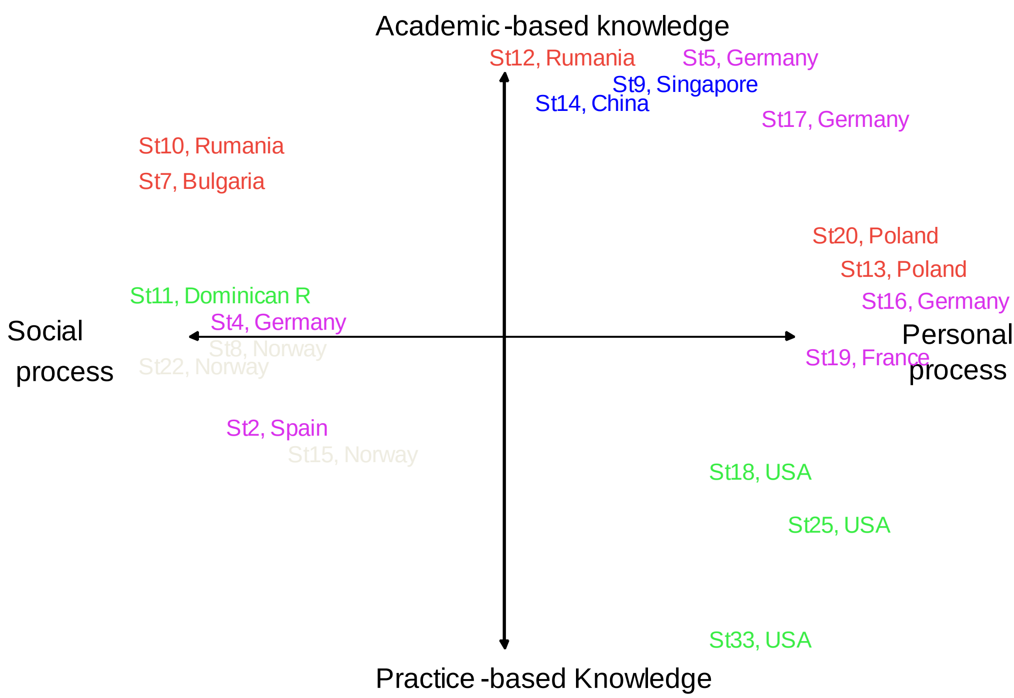

Figure 2. Definitions of learning

Academic-based knowledge: here we included all those references to getting new knowledge, challenging assumptions and creating new ideas.

St17: is about extending and adding to the knowledge, which I already have. Also challenging my ideas and triggering me to take a position.
St5: For me learning takes place when I broaden my knowledge about a topic, heard different opinions, can relate it to what I knew before.
St9: I think learning is about coming away with a thought or idea that you have never thought about before in that way.
St12: Learning could be defined loosely as new concepts, theories, ideas, etc. that have not been either studied at all before, or maybe just touched upon.
St14: Learning is to gain the ability to learn new things.

During the research, we were quite surprised that the perception of learning of individuals was somehow similar within geographic regions. The clearest expression of that was the dichotomised view that US citizens and Eastern Europeans had about the CBS system:

> I can tell you that in my bachelor I was partly studying partly cheating because the things were so boring which I had to study, the exams were same or similar year to year so that you just take the easy way. Here in CBS i find the material interesting, the lectures useful so that you want to study and learn because you see that the knowledge you get will be useful in the future and what ever you learn makes you more intelligent, you become able to speak with wider audience and so on. Studying in CBS makes you broad minded- like think outside the box. (St.24, Lithuania)

> Classes are different in a couple of ways: First, a lot less competition amongst the students. Back home, at a master's level, students push each other to do better – its friendly competition. Second, to me it seems the classes are a bit less structured, for all of my classes, I know there's group work, but don't have the info, deadlines, or what's expected of me as a student. Perhaps its just the classes that I am taking, but the syllabus that was provided wasn't very detailed about this information. At first I wasn't sure where to find it, but in talking with my group members, I came to realise this info just wasn't provided. Also, there is very little class discussion or debate. Its essentially just the teacher/professor talking to teh students. Strategies and business models should be debated and pros/cons should be analyzed i think. Real world business requires quick analytical thinking. Lastly, the role of books and cases or theory verse real world. Here I have come to realize I don't' really need to go to the lectures as its just a reiteration of the book. So why bother? At home, we have cases and data to analyze that builds off the theory (St25, USA).

Thus, learning is contained and influenced by the national context in which is embedded. The research by Kraugh and Bislev (2008), shows that business school teaching across countries reflects wellbeing indexes in their learning styles. For example, a democratic country will have a democratic culture embedded in their learning traditions. Another factor influencing learning is the equality that members have in society, which is also going to be reflected in the educational system of the country.

Several students compared their current experience with their previous one:

CBS is my third academic experience, after high school in Bulgaria and bachelor in France, I have a very broad vision about the different ways of teaching and here for the first time it matches my taste of interaction and active learning, being a part of the building of the classes, I feel it is the right way to learn. (St19, focus4)

I learn different now than earlier, because of the encouragement to speak my opinion and because the materials, at least in my opinion, is different than in my undergrad. I prefer the way I learn now, and I often think that if I could go back in time and learned the way I do now in my undergrad, I would have achieved even better results! Now I have also realized the importance of group work and how one should respect and maybe even elaborate on different opinions. I see myself being more reflected and that I have greater ability to put myself in other peoples` situations. (st22, focus4, Germany)

I think the asking of students' opinion is definitely more frequent at CBS than at my university at home. At home you already had kind of a 'package of opinions' through slides or in a compendium. In class there was much less discussion. We were much more trying to understand the opinion and the theories of the professors. Discussion took much more place in various group works. (St5, focus1, Germany)

Honestly, I haven't learned much here at CBS. It's all so theory bases and half of what we've covered in class has been a review for me. So either I am not paying attention because I've already covered a subject (but in much more detail) or it's so theoretical so as not to be practical, I let it go in one ear and out the other. (St25, focus4, USA)

Compared to my undergrad, I would say learning at CBS is more passive. Group sizes are large, so it can be intimidating to speak up in front of 100 people, and we are given no incentive to participate. I know we all should have the internal motivation, and in an ideal world we would, but some people just need to external motivation, like a participation grade that is then incorporated into your final grade, to give them that extra push they need to speak up. (St18, focus4, studied in USA)

It also affect me as a person in the sense that I have to get used to new teaching methods, different than the ones from where I come from. I believe that this makes me have a more open view towards new methods. It also allows me to compare and to critically analyse them (St2, focus1, Spain)

I would say the truth is somewhere in the middle. Some of the theories we discuss at CBS are so abstract that I know no manager out there will ever sit down and try to apply them. But then in the US, we get to see what works for different companies, but know nothing about the unifying principle behind it, so we do not know in which circumstances it can be applied again. The best would be to take some theories that are on the less abstract end of the spectrum, and then see how real companies apply them and discuss why they work or why they do not work. I want to know more about the industry, the companies, the brands, because at an interview that is what will help me get the job. The theories then will help me do the job. That is would like to see both theory and practice in the curriculum. (St18, focus4, studied in USA)

I have to say that the studying methods like being an active part of the class dynamics, made me gain some confidence in my capabilities to efficiently build new knowledge and to have critical discussions about it. I am saying that because of my French bachelor academic experience which was a passive learning without having the possibility to question the theories/methods. (st19, focus4)

Some of the students acknowledged the problems that group work entails, like communication, negotiation and understanding. But all in all, students were very satisfied with the results of working in groups.

Learning in groups - some like it, some hate it, but it really helps as a learning method. (St6, focus1)

Since CBS teachers are encouraging us in group discussions, class discussions and teams to elaborate on projects it gives me the possibility to enjoy learning again. I missed that many times during my bachelor degree. That's why I came back to CBS after my exchange semester. (St16, focus2)

(Referring to new skills) group-working while writing projects and assignments. (I worked in teams in the past, but I was always starting from dividing the jobs and responsibilities and more or less kept the division to the end. The methods I encountered here at CBS seem to lack this definite division). (St20, focus4)

Group work usually leads me in unexpected direction, and boosts creativity by giving more choices in the process. (St20, focus4)

What I have also learned at CBS is the joy for learning. To be surrounded by people that want to achieve the same, is very inspiring. For example being in a study group has helped me very much! We all want to learn, so therefore we do it together by constantly discussing course material and writing summaries. (St22, focus4)

In sum, different people have different opinions of what is to learn, and how they learn better. Our research confirms that learning is contextual, and that is affected by the national culture where it is embedded. Moreover, we believe that the fact that students can compare their experiences with another learning system makes them more conscious of what its good for them and what does not work. As stated by Marton and Säljö (1997), students who have a previous experience on learning in other countries have more probabilities to be resistant to a reproduction strategy to learning, *they suggested that increased experience in formal education goes together with a development in conceptions and views people have about learning* (Vermunt, 1997).

Hence, these characteristics must be considered within curriculum development, to avoid the one-size fits all curriculum development and to take the most out of students' prior learning and their present experience.

The Role of Professional Identity for Learning (Question 3)

Most of the students were clearly motivated to engage in learning for their future career. In this sense, students were encompassing their personal identity with their professional one. Thus, the perceived professional identities of the students have an impact in their engagement in the courses, so it does in their choice of an approach to learning. Students acknowledge that they chose strategically courses with the objective of being better prepared within their professional field.

> Sometimes can be obligatory courses that I don't find it interesting nor that will enhance my knowledge but in order to get my degree I need to pass the exam so then I have a "pass exam" attitude whereas if is something that is calling my attention I would definitely considered as a gain experience. (St11, focus1)

> I would say I choose what to take based on interest, but also on how it can help me in my future career. I would love to be idealistic and "follow my heart" but money really does make the world go round. (St9, focus1)

However, several students acknowledged that once they had chosen a subject for its relevance for their professional identities, they had been discovering that the subject in question was also contributing to their personal interest, further of the career opportunities.

> For me being not that interested in finance, the course 'accounting and performance measurement' on my curriculum seemed like one of those courses which I had to pass but I thought would not contribute that much for the knowledge base I thought I needed for my life after finishing my masters. I had to change my opinion. Especially in times like now where finance issues have a large influence on all aspects of professional life it is actually very useful to understand (to some extend) the reasons/backgrounds of what is going on. (St17, focus2)

> Sure some classes you just need to pass. But interestingly it sometimes happens that in the end you liked the class in the end although you had a 'I just want to pass' attitude in the beginning. Those are the classes with really inspiring teachers. (St5, focus1)

Students draw from their expected future careers their academic path in the present. Professional identity appears to be a source of clarity, an element that simplifies the complexity of our daily lives and gives stability and continuity to our identity.

> I appreciate the structure of the programme not focussing on just passing exams and learning theories by hard but rather applying the theories to real-life cases and problems. This is important for me as I'm interested in a career in the sector of (project) management or consulting. Therefore I need to be able to connect the theories discussed in class to reality. (St17, focus2)

> CBS gives us knowledge with real situations, and that makes me even more willing to learn and study my course material, so I could be able to apply it afterwards in my future employability (St23, Focsu4).

> I try to assess what kind of skills I should develop in order to secure my future job perspectives. I think that CBS highlights that I can use the knowledge outside school, which was not the case at my old university. Learning process is affected by exchanging ideas and knowledge with other students (study groups) and often imitates the work life situation (case studies).

> When I decide what to learn I ask myself if there is a chance to apply this to the real situation. When I decide how to learn I merely ask the same question: will this particular way of learning something contribute/facilitate the learning process in my future job? (St13, focus2)

Although students take decisions based on their professional identity most of the time, and may take a course with the passing exam attitude, this surface approach can change during the course of the subject, due to the content, structure or the professor.

> I think it pretty much boils down to the teacher. In one of my courses I really dislike the teacher, and so yes, my only goal in that class is to pass the exam, but not for the other 3 classes I'm taking where I feel the teacher is trying to make the content relevant and interesting. (St9, focus1)

> The most important thing that motivates is when you become interested in the issue. If you are interested, you will definitely remember what you have read for a very long time and will not miss any details what you study about. (St24, focus4)

> My orientation to learn has changed mainly because of the different structure – complete focus on assignment (thus practical application of theories) – of my study. It is no longer enough to learn the theories by hard just for the exam day but I rather have to really understand them to be able to apply them. (St17, focus2)

As we have mentioned before, identity cannot be taken as given, but it is a reflexive process that is interpreted by the individual. The student tries to understand "who one is", "how one has become what one is" and "what one wants to become" (Taylor, 1989). In between all the interactions and complexities of the everyday life, individuals and 1st year students specially, try to find continuity between these questions, and draw a path for action. The curriculum of their studies has to encourage this reflective activity, and help them find clarity to define their path, give them insights to change their opinion and help them discover their strong sides and improve their weak ones. In this sense, curriculum development has to include allow class structures and teaching methods that engage the student in the learning process, and make them feel their responsibility in their learning. If the students are conscience of how they can include and take advantage of what they are learning in their professional identity, their motivation and engagement to learn will be stronger in many cases.

Section 3: Curriculum Development

From the above quotes we can draw a number if interesting overall lessons, which have importance for curriculum development. First, students understand learning in different ways. Second, students have different past learning experiences, which affect their participation in current learning processes. Third, studying in an international environment affects students' personal identity in a number of ways. Fourth, students' personal identity affects their participation in current learning processes. Fifth, students' professional identity is affected by the way in which they study. Sixth, students' involvement in their current studies is affected by their expectations of a future professional identity.

If we turn to curriculum theory, it is interesting to see, how curriculum is conceptualised and how such conceptualisations correspond with our findings about the relationship between identity and learning. Curriculum theory has, as we have been able to trace it, evolved conceptually since 1940'ies, and there is an agreement that no unified definition of the term exists (Lynch, 1941; Eisner, 1965; Beauchamp, 1972, 1982; McCutcheon, 1982; Vallance, 1982; Goodson, 1992). Politically curriculum has been addressed in relation to national curriculum reforms in many countries since 1970'ies most dominant in the 1990'ies. Our bibliographic research has led to the following curriculum reform studies: England (White, 1990; Quicke, 1996); Japan (Yoshida, 2002); Malaysia (Dahan et al., 2008); South Africa (Rensburg, 2000; Cross et al., 2002); Sweden (Alkin, 1973); USA (Hammond, 1988).

If one needs to synthesise the research and practice within curriculum theory and curriculum development in particular, it makes sense to present some conflicting dichotomies that surrounds curriculum research.

The first dichotomy is that of "curriculum" vs. "instruction" (Macdonald, 1965). Curriculum is here seen as the plans for teaching, whereas instruction is seen as the teaching itself. The second dichotomy is that of "content" vs. "process" (Herrick, 1965). Here content equals subject matter and process equals instructional design. A third dichotomy is that of "curriculum as a collection" vs. "curriculum as integration" (Bernstein, 1975). Collection refers to curriculum as a collection of courses and subjects, which are not related, has strong disciplinary boundaries between them, and are taught in different ways. Integration refers to curriculum as a related number of courses and subjects, which are integrated and maybe multidisciplinary, and where the teaching methods are integrated across the disciplines. Characteristic about these three ways of conceptualising curriculum is that they have to do with what students have to learn, and the way in which that content is delivered to the students by the teacher through instruction. Curriculum is seen as the overall plan guiding teachers' ways of instructing students. In relation to the above theoretical and empirical discussions of identity and learning in sections 1 and 2 of the article, it becomes clear that such dichotomies of curriculum do not leave room for a reflective interpretation of neither identity nor learning. We have the curriculum plan on one hand and the instructional plan on the other. These views are teacher-centred.

Alternatively curriculum theory and –development ought to take a learner-centred view, and bring into account students and their learning processes. Such would, we will argue, make it possible to account more systematically for the identity and learning of students. In the following subsection we shall look at the learner-centred curriculum.

Learner-Centred Curriculum

A learner-centred curriculum has as its main interest students' development (could be both development of identity and learning). The syllabus and the teacher are of interest only as facilitators of students' learning processes. Learner-centred means that the central actor is the student, and we are interested in ways in which students learn. Learning is central and teaching is peripheral. Typical learner-centred principles give a dominant role to the student in relation to creation of knowledge, planning and structuring of learning processes, modes of investigation, innovation, etc. Learner-centred approaches to curriculum focuses on curriculum as a designed program of learning, and is based on a contextual conceptualisation of learning as described in section 1 of this article. The learner-centred curriculum has learning as a central pedagogical concept. This focus on the learner and learning is not introduced to neglect the role of the teacher in education. However, the teacher becomes a facilitator, who encourages, supports, supervises, and evaluates students' development. This is different from an authority that delivers the right academic content to all students at a specified point in time. The table below shows some alternatives to syllabus-driven didactic-teaching, which suit leaner-centred curriculum, as they force students to make educated links between their own experiences and the academic content. Doing so they have to think of where they come from, what they know, and who they are.

Here we present some of the characteristics, principles and authors for a learning centred approach to learning.

Working with a learning-centred perspective when developing curricula, brings value to the learning process. Placing the student in the centre of the process enables students to learn by induction, developing critical thought and relating what they learn to their personal and professional identities. Learning is not done in isolation of the students' lives, thus, it is important to develop a system that allows the ownership of the learning process to the students, so they can relate and make sense of the contents of their studies.

In this line, we believe that curricula has to allow the student to take control of what he or she is studying, and how this contents and methodologies can help in their future careers. As many students mention, we as human beings normally attribute much more value to that which we find a use for, so it is one of the roles of the teacher to show students how they can use the knowledge that they may initially find irrelevant to their future careers or personal development. We find in our research an evidence that students enjoy more the learning process when a learner-centred approach is applied, which motivate students and brings coherence between the present moment and the future expectations.

Table 2. Learner-centred approaches to education

Leaner-centred principles	Key characteristics	Suggested authors
Case based learning	Students work with analyzing/solving a case. The case can be a "real life case" or a "desk case". The case proposes a problem/or an issue, which students have to analyze.	Mauffette-Leenders et.al, (1997); Erskine et.al. (1998)
Problem based learning	Students work collaboratively with analyzing/solving a problem. The problem can be given to students by the teacher, or it can be identified by the students.	Fogarty (1998); Dean et.al. (2003)
Research-based learning	Students engage in research activities themselves. Teachers introduce to and involve students in current research at their faculty.	Olsen & Pedersen (2003)
Project-based learning	Students engage in larger projects of which they have the main responsibility in relation to locating, analyzing and solving problems.	DeFillipi (2001); Meier & Nygaard (2008).

CONCLUSION

In this chapter, we have presented empiric and theoretical evidence that identity matters when dealing with curriculum development in higher education. Students use their identity constructions to engage in learning within a particular context where they are embedded. Students are heterogeneous individuals with heterogeneous identity projects. In order for them to be able to create a matching personal- and professional identities, the curriculum needs to take into account their identity creation processes, and encourage them to reflect and use their experience in their learning processes.

Curriculum development has to contain the space for directing ones orientations to professional identity, approaches to learn and orientations to maximize the experience of learning.

Group work and POPW helps students to take an active part in their learning process. With group work students interact with their co-students, and get a feeling of membership that enables them to feel part of the graduate programme. POPW helps students to articulate and express their opinions from a personal view, so the student engage as a person in the process of learning and feels ownership for it.

Therefore, curricula have to address issues of identity and learning, establishing a two-way communication from the beginning that allows professors to understand why students are in the class and how they assume initially that they have/want to learn. Professors need to facilitate a process that allows students to create knowledge and become reflective about the content of what they learn.

It is important in terms of engagement that students can relate their professional identities to the courses and curricula, so they can make sense of the situation and bring clarity to the mental picture of their future career. A learner-centred approach is more adequate to include students' professional and personal identity in curricula.

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Chapter 7

CPE 207: Software Engineering

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Abstract

This paper describes a new second-year undergraduate project course in software engineering. The course aims to broaden students' experience, knowledge, and skills. The students worked on six one semester projects. We motivate and assess this pedagogy by our pre- and post-findings, and explain the rationale behind it. The outcome revealed that the students had the capability and motivation to engage in solving many complex managerial, organizational, and technical problems with little guidance and supervision. This suggests that they maintained their focus on the system rather than on individual tasks, which facilitated their understanding of the course material and software lifecycle.

Introduction

The aim of software engineering is to answer the question of how to build software systems within a team environment. This includes deciding on appropriate technologies and tools, learning how to apply and use them, and understanding their purpose, limitations, and impact. These tasks may draw broader implications and they take time to master. When building a software system, many people with various backgrounds and experience work together, which makes their communication, coordination, and planning difficult, and outcome uncertain. In this sense, real world projects and team-oriented student projects share similar prerequisites and problems. The difference is that students do not work to build systems but they learn by doing so. Students' specific needs and work on a project must not overwhelm their other obligations in order that their commitment and motivation perseveres throughout the experience.

Much has been written on how to organize a software engineering course, with arguments flowing for and against additional complexity (e.g., [Liu 2005], [Vliet 2005]). We find software engineering a capstone course, irrespective of what year it has been taught. It should make use of all the different knowledge areas in computing, e.g., computer graphics, databases, HCI, networking, programming, and people and project management. It should instruct students in how to use these knowledge areas together to build software systems, even when the outcomes are uncertain.

Depending on the academic year, these expectations may appear unrealistic, especially for a second year course, which makes the task for the instructor even more challenging. In particular, the laboratory project should promote broader considerations and creativity. It should refrain from mechanisms that are incompatible with the environment, as well as from unnecessary simplifications.

Software engineering is concerned with system design, and Simon [Simon 1984] called design tasks ill-structured. Furthermore, in design, problem specification and solution construction are intertwined tasks. According to Senge [Senge 1990], we are taught from an early age to break apart problems and, in doing so, we lose our intrinsic sense of connection to a larger whole. Students should experience that solutions are sometimes not readily available, and that outcome is a shared responsibility. The uneven distribution of knowledge among students, lack of skills, and diverse personalities must not turn into distractions that cannot be managed. However, a course should not be scaled down. Instead, targeted assistance should be provided if and when necessary for the students to make uniform progress.

This paper elaborates on these ideas, describes the course CPE 207, and reports on six large laboratory projects. The approach and decisions are motivated both by our professional and teaching experience, and other sources. CPE 207 is a mandatory second year course in software engineering. It has been attended by 425 students over a period of one semester.

PRIOR EXPERIENCE

The syllabus of the previous software engineering course was composed according to a snapshot of the needs and practices of local companies. Both the object-oriented method and the structured method were taught simultaneously. They were portrayed according to the software lifecycle, but they were not tied to a programming language. An introduction to software cost estimation models was also presented. In the laboratory, students decided on a simple project to work on within teams of six or eight. Each student took on a separate role, such as a customer manager, designer, developer, project manager, or tester. The laboratory manual promoted a top-down decomposition and linear process. During each week, students worked on a different task according to their role. Their work was evaluated only at the end of the semester.

This approach revealed some negative learning patterns. Although the theory was presented well and the examples were focused and simple, most students failed to differentiate between the two analysis and design methods. In the laboratory, they mixed them up as deemed convenient. A number of factors might have contributed to the confusion. The examples were fragmented and unrelated, and they did not address the same problem from specification to resolution. Different examples were used for each method, and no software program was used to implement a design as to make the methods more accessible, i.e., less abstract. The different decisions were not accompanied with explanations about their rationale, all of which resulted in a course overloaded with unrelated information.

In the laboratory, we found that the dataflow diagram was most often used and the diagrams appeared detailed and refined down to the second and third levels, with students hardly ever venturing into structure charts. UML [Arlow and Neustadt 2005] was far less popular and within it the sequence diagram was the most popular. It was unusual to come across a class diagram or use case. Because each lifecycle phase was approached in isolation from its predecessors or successors, the captured information and problems addressed were very small in scope.

Most students had no experience with or proper understanding of the purpose and significance of real world project roles. The functional roles, when practiced, were detrimental to their learning. When students work together as a team, as they should, their individual roles become irrelevant, and when their work becomes role specific, then teamwork is weakened. Thus, the developers produced a system on their own, and the testers had nothing to test because they were unfamiliar with the implementation. Overall, the requirements were vague and the architecture was completely omitted. During the whole project, a lack of details and need for controlling and estimating was evident. Eventually, there was always someone who could implement a simple prototype right before the end of the semester.

During the lectures, COCOMO [Boehm 1981] and Function points [Garmus and Herron 2000] were introduced before the software lifecycle. They both failed to provide insight into the planning because they were difficult to relate to and understand. As a result, the students were unable to use Function points and assumed that COCOMO produced the exact result, not an estimate. The students frequently questioned the instructor regarding *whether or not to round the number of man-months up or down*?

The laboratory supervisors also had to deal with a lack of control over teams and their own work due to students alone making decisions on the project. There are two dimensions to supervisory control: a) behavior that refers to the extent that a supervisor monitors and evaluates the behavior of subordinates as to assist them, and b) outcome that indicates the extent to which a supervisor evaluates outcomes and monitors subordinates [Santana and Robey 1995]. In a university environment, the former is concerned with coaching in the use of software engineering methods and tools, and the latter deals with development goals and objectives and initiating corrective actions as necessary.

In past projects, supervisory control dimensions were weak because the supervisor was unfamiliar with both the intentions and means, and could therefore provide little quality guidance and input. The transactional nature of the marking model did not reward or stimulate applying a corrective action, thus further reducing the benefits of the supervisory involvement.

These problems aside, a fair number of students had good programming skills. They adequately knew the programming languages for online applications and software architectures to support them (e.g., HTML, PHP, RDBMS, client-server, and three-tier), none of which had been addressed before or during the course. Students could decide on and build simple applications for match-making, online shopping, or ticketing often supported by a RDBMS. MySQL [MySQL] used to be their preferred RDBMS choice.

CPE 207

CPE 207 has been prepared according to the findings and ideas described above. It has focused only on one analysis and design method, i.e., the object-oriented method, wherein the same techniques of modeling can be applied to software artifacts and processes. The software lifecycle and the object-oriented development model are understandable as they originate from the experience of many (albeit proven difficult to apply in practice, e.g., [Lemon et al. 2002]). Instead of applying algorithmic models, students should make their estimates and plans based on their own understanding of the problem and task at hand. CPE 207 engages the motivation and skills of students in a project that is controllable, dynamic, formal, and relevant. The laboratory allows students to more thoroughly apply software engineering theory and to experiment, as it reveals the complexity and interdisciplinary nature of software development.

Many authors dealing with this topic qualify the attributes *real world, large scale, and complex* as desirable when describing the laboratory project. We believe that these should be understood and approached in such a way that the classroom and the laboratory become tightly integrated. In our approach, the term *large scale* means a software system rich enough in features to engage a laboratory session of about 80 students. *Real world* refers to a familiar application domain and easily understood system requirements. *Complex* refers to being capable of incorporating most if not all elements from lecture material. Anything less than that is inadequate and anything more than that is unnecessary.

The problem then becomes how to balance what is readily available with those elements that students should discover and work on themselves. When the project is too simple its importance might be missed, and when it is too hard, it may be demotivating or result in errors that cannot be easily identified or rectified. When preparing for projects, there are both known and unknown risks. The CPE 207 instructor must remain attentive and offer assistance so that the project can move forward. This suggests a dynamic relationship between the laboratory and the lectures. A topic may have to be revisited or more lecture material added as necessary. For example, our past experience led us to conclude that the students were good programmers. In contrast, CPE 207 has revealed that programming help was needed to overcome certain difficulties. We attribute this to a much broader involvement, which has clearly not been the case in the past.

When dealing with abstract problems, such as modeling, students may experience difficulties and a lack of discipline. Students cannot confidently make far-reaching decisions because, first, they have to comprehend the theory and develop the skills. It is important that students implement their ideas in code because without a working system the whole enterprise would lack direct verification and purpose. At times, students are able to reverse engineer their prototypes if it facilitates their decision making and understanding. However, as a whole, the project cannot be reverse engineered, and it should not become an exercise only in programming or learning about tools.

Students use popular tools for software development, such as Java and the J2SE platform [Java], and generally did not experience any problems using them. However, we organized two one-hour laboratory briefings in reaction to their difficulties with HTML, MySQL, and Java related technologies, such as JSP, RMI, Servlets, and Tomcat. After the briefings, a majority of students' programming work consisted of inclusions and modifications of our examples into their code. As a result, they had more time to concentrate on other tasks, such as analysis, design, integration, and testing, correcting and discovering problems, as well as keeping their work products up to date. The final mark took into consideration all the lifecycle-related work products, as well as meeting minutes, release notes, and status reports.

Lectures

The syllabus of CPE 207 was defined according to the textbook *Object-Oriented Software Engineering Using UML, Patterns, and Java* [Bruegge and Dutoit 2003]. The textbook deals effectively with the complex issues of software development and provides enough information to implement a complex object-oriented software system. A reader does not get overloaded with details that are not immediately applicable in the laboratory. The textbook starts with a broad-brush introduction to software engineering, UML, and project communication and organization issues. It then details the software lifecycle (i.e., requirements, analysis, system design, object design, and testing), followed by change management as per rationale, and configuration and project management, respectively.

Many of these topics are practiced in simple and small projects, especially when a process driven-software development approach has been used. However, the problem with this approach is that it leads to a linear model without ambiguities. It fails to reveal that software engineering is non-algorithmic, as it often requires making tradeoffs. Nontrivial projects are accompanied with uncertainty that must be constantly dealt with [Arnoud et al. 2002]. Furthermore, small software systems are unsusceptible to cohesion or coupling, and layering and partitioning are of lesser importance because change, if any, is easy to manage. Small teams can experiment with only one architectural style or design pattern so that most of the theory is never used for solving a useful problem.

Roles and Skills

Most software projects consist of a team or teams of engineers and managers who should have their skills drawn from both the hard and soft sciences [Berndtsson et al. 2002]. Hard skills are composed of processes, techniques, and tools. Soft or people skills, such as communication, conflict management, creativity, leadership, and team building, are acquired through experience. The expectation of skills applies both to large and small projects.

Our goals regarding skills and their realization can be briefly summarized as follows:

- The software engineering body of knowledge is complex and large, and a software engineer should avoid becoming a narrowly focused expert. For the purpose of broad insight and to equally develop their hard and soft skills, all students work on all the lifecycle activities.
- Software engineering concepts and decisions on software engineering projects are often interdependent [Washizaki et al. 2005]. Therefore, laboratory and tutorials should share one approach and other elements that lead to a comprehensive solution to a problem.

- Students must be familiar with the application domain, so that they can easily understand the problem at hand. The solution domain and the applied techniques must be appropriate and relevant, and they should offer many opportunities for creativity and experimentation.
- Students develop their soft skills in an environment that most, if not all, students find controllable and motivating. Students learn to work in a project team under little supervision.

For the laboratory, we decided on a multi-team project. We opted for a flat organizational structure (Figure 1) and nonlinear information flow in which each student gets involved in all aspects of the project. This served our educational goals and, given their level of experience, we believed students would find it manageable. Each of the three roles (i.e., developer, team leader, and web admin) assumed programming work. In addition, team leaders were expected to liaise with other teams, prepare weekly progress reports, and participate in weekly progress meetings with their laboratory supervisors.

The nonlinear information flow encourages students to interact across team boundaries, rather than concentrate only on their own work. As explained below, this organizational model and level of student engagement is facilitated by the system architecture.

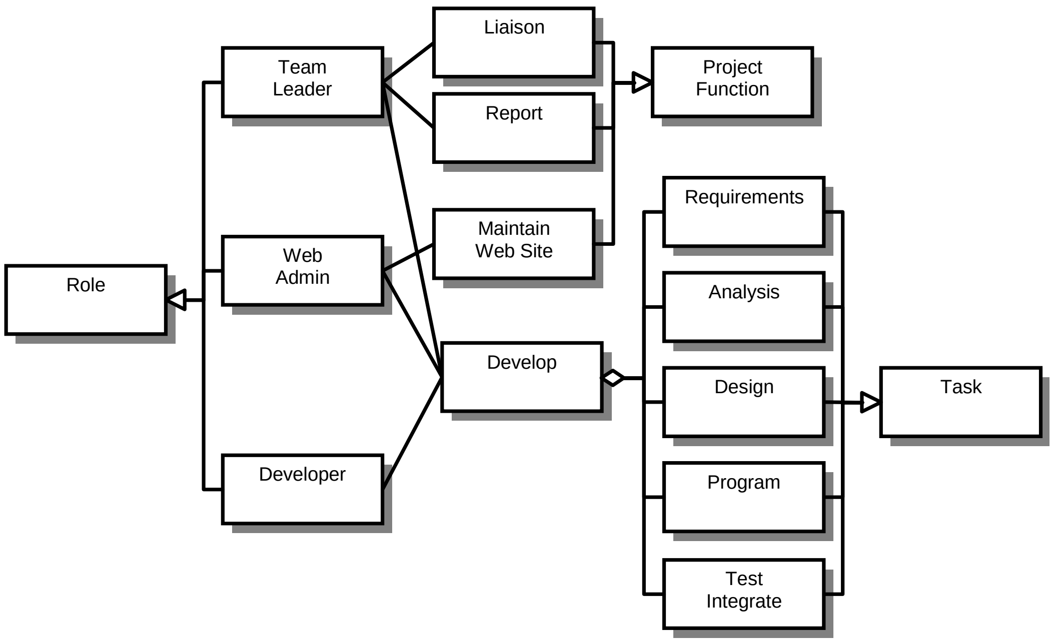

Figure 1. Horizontal differentiation and tasks

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- 3.1 Functional Requirements
- 3.2 External Interfaces
  - 3.2.1 User Interfaces
  - 3.2.2 Hardware Interfaces
  - 3.2.3 Software Interfaces
  - 3.2.4 Communication Interfaces
- 3.3 Nonfunctional Requirements
  - 3.3.1 Usability
  - 3.3.2 Performance
  - 3.3.2 Exception Handling

Figure 2. Requirements analysis document

Process

While working on the project, the expectation is that each student will produce one or more related classes, integrate and test code, and document the work as per software lifecycle. All of these individual tasks are part of the work package. We mandated what documents would be produced by students individually and by teams, but not the content. Not all UML diagrams are applicable in all situations, and not all work packages require coding or testing. For example, some students may only work on graphical images or models used in animation. We provided the guidelines and templates for each document type, such as meeting minutes, object design, problem note, release note, status report, requirements, system design, and test plan.

Figure 2 shows the Table of Contents for the Requirements Analysis document. The template has six pages and provides a brief description of the meaning of each section and subsection, and the type of information that should be provided. Section 1 introduces the document to the general audience. Section 2 presents a high-level summary of the system or subsystem, and describes its main features and development guidelines. In Section 3, the team details the requirements.

Students work in teams, and all teams in a laboratory session of approximately 80 students work on one project. The project builds a distributed system that consists of a number of subsystems. Each team is responsible for one subsystem. The major steps at the beginning of the laboratory include:

- Preparation – each student is handed in advance a copy of the Laboratory Manual. Students are briefed on the project, its important aspects, and expectations before the laboratory gets started.
- Forming teams – students are free to join a team of their choice. It has been found that when members of a group share common personal factors, such as interest or motivation, they are inclined to work together [Aranda et al. 1998]. Students must remain with the team because changing teams would disturb the project since the work package must be dropped or picked up by another student. Given that the system is complex and the timeframe is short, it is difficult to catch up with a new team.
- Understand the system architecture and the subsystem as described in the Laboratory Manual. The project builds a distributed Public Bus Simulator (PBS) system (see Figure 3 below).
- Define requirements for the subsystem and system. Each student then decides on a work package according to individual preferences and team consensus.
- Work on lifecycle activities, including task estimation and planning. These are explained in the Laboratory Manual, lectures, and textbook. The expectation is that students will make estimates and schedules based on their understanding of the work involved, such as what diagrams to create, the complexities of the classes and their interactions, and the many interdependencies with other work packages, rather than by using an estimation model, such as the two mentioned above.

Students first familiarize themselves with the problem statement and the PBS system as presented in the Laboratory Manual. They elicit the requirements within their team and together with other teams. Then, they decide on their work packages, which they carry throughout the project. They make their own estimates and combine them until a project schedule gets defined. The whole process, its phases, and work products are as described in the textbook. The document templates have multiple sections, and each section is accompanied by a brief description. To help with project planning, the Laboratory Manual provides a simple example with more details.

Students are expected to implement an iterative process model with three iterations (e.g., [Dawson 2005]). They are taught how to build a system incrementally by identifying the critical or most important features at both the subsystem and system levels, and stabilizing it upon each increment. In principle, each iteration should produce a complete set of documentation and some executable code, which constantly requires a broad set of skills.

The iterations should create a sense of urgency and speed up the process because they are shorter than the semester. We want to avoid a situation in which most knowledge is acquired and work is completed towards the end of the semester. This quite possibly might result in uncoordinated efforts and failed projects. It takes eight weeks to lecture the object-oriented software lifecycle (i.e., UML, requirements, analysis, system design, object design, implementation, and testing). If the first iteration can be completed within the eight weeks, then the remaining four or five weeks can be devoted to improving the prototype and work products in one or two iterations.

A problem occurred that we were aware of when preparing the laboratory, which was caused by the educational process itself. The process is linear, and the lectures form a sequence of topics that spans a whole semester. This raises the question as to whether there is sufficient knowledge available to the student when needed; and the answer must be an emphatic *no*. Experience has shown that engineers cannot simply work their way down a list of steps but must circulate freely within the proposed plan, such as skipping stages almost at random and backtracking [Koen 1985]. One would expect that for those who lack the experience and knowledge of a professional, this type of flexibility is essential.

To overcome this problem, the students were advised to explore and forward learn on their own, if necessary. Estimating effort and planning on real world software projects is still difficult, and even more so in this case because students, for example, do not yet understand the lifecycle. The textbook addresses these topics in the final chapters, while these tasks have to be worked on early during a project. A laboratory manual, as a concise and targeted source of information, can effectively assist in resolving such conflicts, and we took advantage of it. As our experience has shown, all these resulted in our students being more proactive in seeking answers and help from the laboratory supervisors.

PUBLIC BUS SIMULATOR

Just as we do not want students to work on any project, we also do not want them to build just any kind of system. The Public Bus Simulator (PBS) project met our goals since everyone is familiar with buses, public transportation, and traffic control. This makes a problem statement easy to understand and refine. We also defined the system architecture such that it must be elaborated upon by each session and team in terms of its subsystem design and interfaces in order for a functional PBS to be built. In this way, students were provided with a fair and targeted framework to work within, but each project defined, designed, and implemented a unique PBS with unique subsystems. In other words, quality, scope, and time are under the students' complete control and responsibility.

Subsystems

The PBS system is a distributed system with seven subsystems (Figure 3). Each subsystem runs on a dedicated PC, and they interact by making Java RMI calls. The subsystems are described as follows:

- City Map Editor – enables interactive definition of a 2D city map with streets, traffic signals, buses, bus stops and routes, passengers, roadblocks, bridges, etc.
- Control Center – is the central registry for subsystems and serves as the forward request facilitator between the subsystems. It has a GUI to start and stop an experiment, and signal the availability of other subsystems. It receives and displays

important events from subsystems. Upon startup, each subsystem must first register with the Control Center and query for a Database node.

- Database – stores city maps, bus timetables, and other persistent information. The Database subsystem has a Java RMI frontend to interact with other subsystems, and it uses a relational database that is accessed via JDBC/SQL (see Figure 5 below).
- Navigator – directs buses along routes, as per city map. The Scheduler sends requests to move a bus forward, and the Navigator forwards a new position of the bus to the Tracker, and notifies back the Scheduler when the bus has arrived at a bus stop.
- Scheduler – schedules buses to their timetables, operates traffic signals, and manages passengers. When a traffic signal changes its state, the Navigator and the Tracker get notified. When a bus arrives at a bus stop, the Tracker gets notified to update the number of passengers on the bus and at the bus stop.
- Setup – provides web pages to initialize and reconfigure the PBS at runtime. Update requests are sent back to the Database and distributed to other subsystems via the Control Center.
- Tracker – displays a city map with dynamic updates as the buses and passengers move in time and traffic signals change state.

In addition, we also defined the Web Site, which is not a PBS subsystem:

- The Web Site – is a critical component that serves as the repository for work products, and a forum. Work products can be both uploaded and accessed online but only by project members. We defined the features that must be supported in order for us to mark the work products.

Figure 4 shows the hierarchy of Web pages offered by the Web Site. There are two sections — one for each subsystem and one for the project. These are also organized in two sections — one for nontechnical (i.e., managerial and organizational) documents and one for technical documents. Each section has subpages that are content specific, such as requirements, design, and schedule. The implementation details and user interface were left to the Web team and project to decide.

Teams

It is impossible to predict the exact number of students per course and per laboratory session, and the number of enrolled students depends on the semester. In the spring semester, there are approximately 420 students, typically forming five or six laboratory sessions. In the autumn semester the number drops to roughly 70 students and only one laboratory session. In both cases, the project should be equally demanding and flexible. During the planning, we assumed 80 students per laboratory session (i.e., project). However, we estimated that having fewer than 62 students per project would make it too demanding to complete. The estimated size of each team is presented in Table 7.

Table 7 Team size based on 80 students per laboratory session

Team	Size	Team	Size
City Map Editor (CME)	18	Scheduler (SCH)	6
Control Center (CC)	7	Setup (SU)	9
Database (DB)	9	Tracker (T)	10
Navigator (N)	15	Web	6

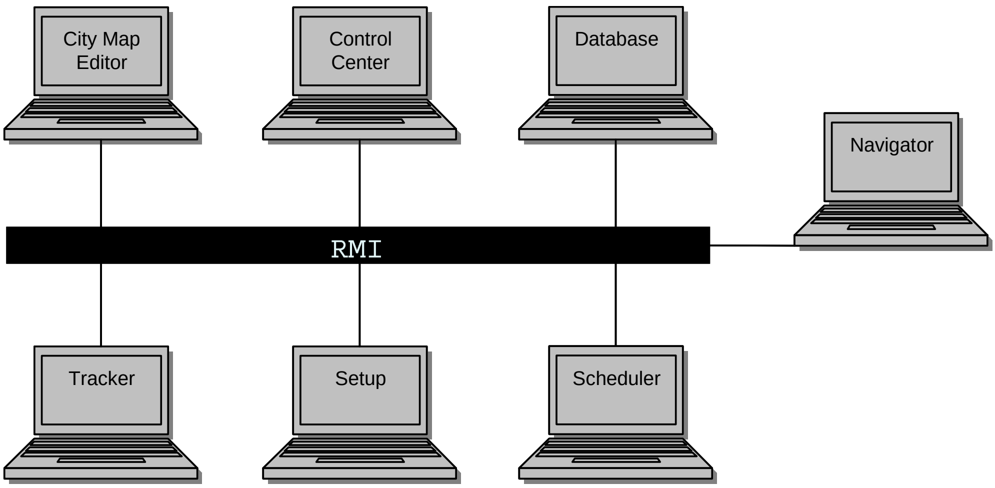

Figure 3. Public bus simulator subsystems

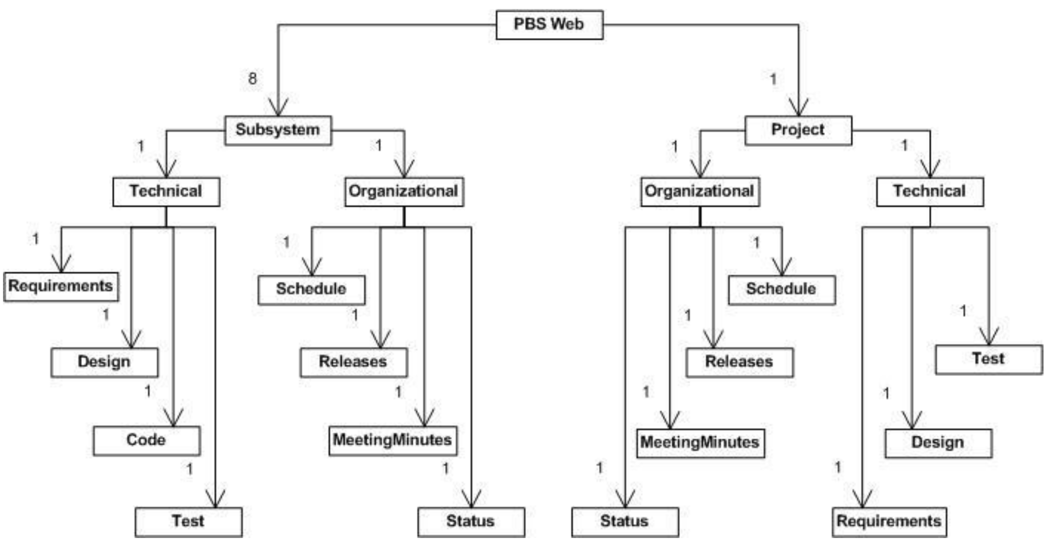

Figure 4. Hierarchy of Web pages.

As a rule, it is easier to make a large team even larger in size, than to make a small team smaller. Therefore, when a session has less than 80 students, we more aggressively reduced the size of the large teams. No team should have fewer than five members. For example, the Scheduler team could be smaller than six, but no larger than seven since no additional features can be added or, for that matter, be removed. Small student teams tend to suffer from the following risks:

- One student can do all the work. Rather, those who have the programming skills and practical or professional experience should help move the project forward.
- We do not know and cannot predict how many students will initially be unable to perform their tasks. Small teams run a greater risk of becoming stuck or, as a tight-knit group, failing to interact with other teams.
- We cannot predict whether one or more students will drop out, which can overload the remaining team members.
- Small teams do not necessarily perform better, particularly if they have not been formed purely on the basis of interest in the subsystem.

Still, the Web team is deliberately small, even though their requirements could easily be made more complex, which is, in part, contingent on their willingness to consult with other teams to establish what their preferences towards the Web Site might be. The Web Site subsystem does not depend on other subsystems. Therefore, we hoped that a small team would be easier for the instructor to control. Technically, the work they do is similar to the Database and Setup work combined together (i.e., Tomcat, JSP, HTML, and MySQL), but much smaller in scope.

To simplify interactions, large teams have been encouraged to form subteams based on the closeness of their work packages. Each subteam elects a leader that can liaise with other subteams or teams, as necessary.

Technology

To build the PBS, the following technologies were selected:

- Java 1.5 – Java provides all elements that are necessary to build this system on a single development platform. The textbook makes use of Java, and Java is a mandatory first year course at the university.
- Java 2D – a framework for device- and resolution-independent 2D computer graphics.
- Java Server Pages (JSP) – separates the designing issues from the programming logic.
- HTML – needed only to present database tables and to implement an access control and file uploading for the Web Site.
- RMI – a programming interface for performing the object equivalent of remote procedure calls.
- Apache Tomcat 6.x – supports Java Servlets.
- MySQL 5.0, Administrator 1.2, Query Browser 1.2, and Connector/J 5.1 – popular tools in public domain [MySQL].
- Visual Paradigm Standard Edition for UML [Visual Paradigm].
- Microsoft Word for documentation.

Since most of these technologies had been used in past software engineering laboratory projects, we expected that our current students should also have at least some exposure to the development environment. Further, in a distributed application it is important that the subsystems share the same philosophy and technology so that they can share code and design, and that they are easier to integrate. Java and J2SE provide the platform on which these needs are met. All these tools are in the public domain so students can install them on their own PCs and practice.

Rationale

Distributed systems create technical problems that must be assessed against a monolithic system. In a monolithic system, the software engineering methods and techniques may not be easily enforced or even necessary, because everything that is functionally supported and known could become readily available. On the other hand, a system with distributed architecture requires a networking layer for interprocess communication. However, good design decisions lead to simple, scholastic solutions and fast implementation, benefits of which should be exploited. Similarly, the size of the project is such that it requires dedication and teamwork that, in turn, make change and day-to-day project management a constant concern to pay attention to.

Below, we detail the learning outcomes and our rationale when preparing the laboratory:

- Each team defines its requirements and design and these affect other subsystems. They deal with both application and solution objects and how they change depending on the subsystem. Students aim at an elegant and simple solution, with little or no redundancy and a potential for code sharing among teams.
- When defining relationships between elements, measures of goodness include cohesion, completeness, and coupling [Booch et al. 2007]. Clean and firm element boundaries make the relationships between the elements in a realization more stable. Their individual semantics become easier to define and refine at a lower level of abstraction.
- Students learn that a subsystem can simultaneously act as a client or a server, or both. This became important when a RMI interface was implemented for each role within one process. Students experience firsthand that the architecture of a complex system need not conform to a single style, but different subsystems may use different architectural styles.
- Students learn that architectural decisions have a far-reaching impact and may require many interactions, while object design decisions are concerned with local and low level details that are dealt with within a team. Yet, changes must be dealt with constantly and promptly.
- Students learn to use packages for layering and to avoid potential naming conflicts. To make the design and implementation consistent and easier to understand, students build a repository for constants and global variables that are used in many places. In doing so, they have to recognize and address possible concurrency issues.

- Students learn to apply a number of design patterns, such as adapter, façade, iterator, proxy, and singleton [Metsker and Wake 2006], to solve meaningful design problems. In addition, they experience their value when working on a sizeable software project with complex dependencies that cannot be all resolved at the same time.
- Students get to model with boundary, control, and entity objects to realize use cases. They are exposed, either directly or indirectly, to multiple design patterns while solving meaningful problems.
- What are the common PBS abstractions, as opposed to subsystem specific assumptions and representations? For example, do Database and Scheduler share the same notion of Bus? Should there be a single system wide Bus class and, if so, who should define it or contribute to its definition?
- How do the system-wide abstractions affect coupling and the interfaces? For example, the Database has a Java RMI frontend to reduce the coupling of the subsystems (see Figure 5 below). This design provides uniform communication of data between the subsystems.
- How are events generated and propagated throughout the PBS? Who is interested in those events and how are they handled? What is polling and how is it used to implement a robust application?
- Where does the concurrency fan out and how is it propagated through the system? Does it get affected by the distributed architecture? How does the communication middleware handle concurrency?
- In what order should subsystems be started? How is a system designed for which ordering becomes irrelevant? What happens if a subsystem moves to another PC? Should the whole simulator be restarted?
- Students learn not to freeze design early on but at a point where their system and subsystems become sufficiently complete and evaluated, and there is enough resources and team knowledge to implement it.
- Project management is a set of choices that must be constantly evaluated. Time and other resources are precious and must be used wisely. Planning is not easy, especially long term planning for which this environment lacks prerequisites and students lack the knowledge. However, control and motivation among peers may be even more difficult, and here it becomes very realistic.
- Features and problems must be constantly evaluated and prioritized, as does the students' commitment. All these make both nontechnical and technical risk palpable and its effect on outcome recognizable.
- Coordination of dependencies in a task conducted by multiple people or teams is difficult [Kraut and Streeter 1995], and even more so when, most of the time, teams are not collocated and lack experience. Students learn how to manage these dependencies by precisely communicating, either orally or by exchanging artifacts and organizing activities.

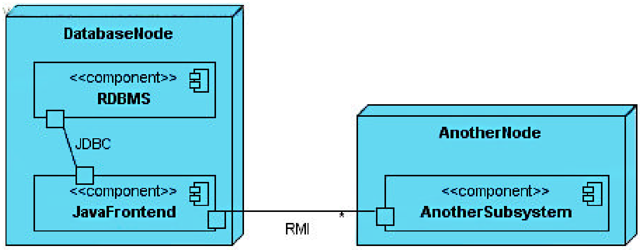

Figure 5. Database components and dependencies

Laboratory Manual

The Laboratory Manual has 34 single spaced A4-sized pages, including 17 UML diagrams and figures. In addition, 63 slides accompanied the two outstanding laboratory briefings. The Laboratory Manual describes the PBS system and provides information on project estimating, incremental development process, and planning. It complements the textbook by providing the missing information and targeted examples. For example, it provides hints and suggests a generic approach to the design problems specific in interactive graphical editors. It describes the interaction between subsystems (see Section 4.1), but the information is fragmented so that it can be scattered around. Students are expected to follow these leads and decide on the missing elements.

The Laboratory Manual is written such that students, irrespective of the team they have joined, must read through the whole document. They must learn about their own subsystem and about the whole PBS. Whether these appeared unexpected or not, the scattered information produced the outcome that we hoped for. For example, roadblocks are part of a city map. Roadblocks are mentioned in the Scheduler section, even though Scheduler is not concerned about city map and roadblocks.

The idea here has been to test students' understanding of consistent requirements, cohesion, and how to apply these principles in practice. The students understood that the Scheduler does not use a city map. However, on all the projects, the Navigator team argued that the Scheduler team should be responsible for the algorithm to avoid roadblocks. (Or could this be a case of less work over sound engineering?) To resolve the argument, the laboratory supervisor had to explain how to proceed.

FINDINGS

Students differ vastly in their knowledge and motivation, but within a university environment, their background and skills come a distant second to their individual preferences. The mechanisms of control are very limited in student projects because students typically find it difficult to manage one other or to be managed. Therefore, it is important that each student actively participates in all nontechnical and technical decisions that affect his or her work. Supervisors intervene only when there are conflicts and issues that students cannot resolve themselves, either because they do not have the authority or the knowledge to do so.

To the extent that supervisors could influence these projects, we did not find the projects difficult to manage.

Most of the students decided which team to join before the laboratory started, and the team formation proceeded smoothly. Students who belonged with large teams easily formed subteams; but students preferred to work together as a team in the laboratory because that was likely their only chance to do so easily. More importantly, each team and project had to reach a consensus regarding their goals and involvement. They all had to learn how to avoid negative conflicts, cope with team inertia, etc. Given the number of students who worked on the projects, this required a considerable effort. However, the level of students' interest was high and the individual work packages were manageable both in complexity and size. All these have proven instrumental in overcoming both the difficulties of learning and working at such a large scale.

The laboratory supervisors took two different approaches to their involvement:

- In the first approach, the laboratory supervisor appointed team leaders, and steered the project by providing guidance to team leaders on a weekly basis. At the start of the semester, the supervisor asked the students a number of questions as to establish who should become a team leader. The questions targeted students' background and technical skills and tried to match them against specific subsystem features. Of course, those students who appeared qualified for the role should also be willing to lead a team.
- In the second approach, we assumed the lectures and tutorials provided enough information for students to perform their work. Therefore, the supervisor was primarily concerned with technical risk management or, more precisely, providing assistance only when needed or when students asked for it. Therefore, students were free to appoint their team leaders and work on the project in a manner that they found suitable. The idea here was that students know one another well enough to determine who among them is the right person to lead. Since students learn from and help each other, the laboratory supervisor should gain enough insight into the project status and prevent major misconceptions and mistakes from developing and spreading.

In retrospect, the first approach initially appeared as if to generate more momentum, but soon the amount of activity at the top and at the bottom became disproportionate. It created a two-tier organization which was not desirable since students must learn that they are equally responsible for the outcomes. The second approach detected more problems and provided more suggestions, as most students were preoccupied with technical issues. Working with a whole team rather than team leaders served the teams better and more questions were answered. Here, the word *working* means participation, but not driving a meeting or project in general. The online fora proved invaluable, being active late at night, even during the one week midterm break. They made problems and ideas public and enbled us interact with students at any time, even while away from the university. These findings, however, do not negate the importance of active laboratory supervision as a means and help teams.

Initially, the students spent much time contemplating and negotiating requirements, without paying attention to the cost of all those fancy features and their feasibility. For example, a Setup team wanted to implement a use case by which it would be possible to change the route of a bus in a Web page. A bus route is an ordered collection of road segments. To define or modify a route, one has to use the City Map Editor. The Setup subsystem displays bus routes in a table, which makes the use case impossible to implement. After the idea was accepted by other participants in the meeting, the supervisor had to point at the problem.

However, situations such as these are not all bad because they also reflect the excitement about the project. Brainstorming sessions help teams to bond and know other students and teams better. Projects cannot happen instantly, especially because students' approaches to learning and orientations to studying are different [Felder and Brent 2005]. It takes time for a team to get going, just as it takes time to gain confidence in applying a technique or, for some, to start communicating their ideas freely. Also, some requirements may be harder to document or understand and need more discussions and studying.

A departure from the process model or project plan does not always mean the time was wasted. A simple prototype is helpful and stimulating. For example, one Tracker team started their work by reusing their code from another course. This propelled their efforts far ahead because they understood the tasks ahead. Instead of struggling with a bare minimum, they contemplated advanced features and graphics. The momentum extended to their documents that were complete and among the best we examined.

Was the iterative process model practical in this environment? It is difficult to answer that question with a simple yes or no. For a project to iterate successfully, the project teams must be appropriately staffed and the staff must adopt a collaborative, opportunistic, and self-directed approach to software development [Kruchten 2003]. While constant attention and engagement are necessary to help each other out, individual contributions are subject to demand and prioritization. These prerequisites are not easy to eventuate.

Our expectation was that by giving students the freedom to experiment and explore, they would be able to overcome their lack of experience, knowledge, and skills. These require that problems and tasks in which students engage are manageable and understandable. Some teams succeeded, i.e., those who understood both the what and the how. Other teams preferred to work in a more linear model because they had become accustomed to it during their studies. These students simply followed the lecture plan and made slower progress, but it also made them more confident in their knowledge and work, and in meeting the course objectives.

Some teams wanted to design and build a better subsystem and thus spent more time on exploring and rework, which made them less responsive to the needs of other teams. We do not regard this as a critical problem, though, because students should be confident and comfortable with their progress and work. Racing against time just to implement a system should not be their first priority. They are only learning how to design software, document ideas, and work as a fully engaged project team. However, laboratory supervisors should help bridge the gap by reminding them of other needs and teams.

A nonlinear process is beneficial because students learn better by revisiting previous phases and tasks and improving upstream work products. By doing so, they can establish dependencies between activities in the software lifecycle and between work products, and their importance. We believe that the absence of functional roles and teams from the project has been an important contributor to the students' learning and project control. It was not possible to adopt an over-the-wall [Shorter College 2007] approach to the system development in which unfinished or untested code and specifications are passed on downstream. Since all students remained engaged, the handling of errors was more efficient and easier.

However, a nonlinear process cannot develop spontaneously, and another reason was found in the opportunistic behavior of students when managing their effort and time towards classes. For example, students often rationalize that additional effort and rework are worth it only if rewarded. We introduced two mechanisms to address this problem: asynchronous communications via the forum or similarly made up-to-date information accessible to everyone and stimulated action. In addition, students could resubmit their work products beyond the deadline and earn a better mark. Most students appreciated that opportunity, and most teams submitted the final version of their work products during the last laboratory period.

A design or project with no implementation lacks validation and closure. For this project to become successful, the main design ideas and features must be implemented in code so that the subsystems can be integrated into a functioning system. However, simply writing code was not the objective of this laboratory project, as the nominal average of about 310 lines of code per student for the six projects suggests. The students' feedback confirmed that the code samples from the two laboratory briefings eased the need for programming work and self-study.

In order to demonstrate the goals, such as those mentioned in the above subsection on rationale, have been realized, a clear relationship must exist between the artifacts within each team and the whole project. The multisubsystem dependencies and the multiteam environment reinforced the need for ongoing collaboration and made a pure reverse engineering approach impossible. These would be difficult to achieve without the single development platform provided by Java and the single design method supported by UML.

OUTCOME

There were seven laboratory sessions that formed six projects. There were between 65 and 110 students per project. The 110-student project (i.e., Project 1) was composed of two sessions (i.e., Sessions 1 and 2 in Table 2) that were scheduled on two different weekdays. As a result, they often doubled their laboratory time by attending the other session's laboratory. The outcome as per projects' completion is summarized in Table 2. The Web Site is a standalone subsystem that did not integrate with the PBS. Therefore, it is marked only as completed. Because of the complex interdependencies between the subsystems and teams, the produced designs and code clearly demonstrated that each project aimed at a unique overall solution.

The systems developed by Projects 1 and 5 were fully integrated, but System 5 had fewer features. System 1 included approximately 291 Java classes and 33038 lines of code (LOC), 27 JSP with 2119 LOC, 26 HTML files, and 39 WRL files. System 5 had about 250 classes and 30 KLOC, 24 JSP with 1750 LOC, and 4 HTML files. On the subsystem level, according to Table 2, 32 subsystems were integrated, 10 were not integrated and two of these were incomplete (i.e., Navigator 6 and Tracker 7). Project 1 produced two Web Sites, one for each laboratory session.

Table 8. Outcome (C=completed, I=integrated, N=not, P=partially, 3=Java 3D)

Session	CME	CC	DB	N	SCH	SU	T	Web
1		I		I	I	I		C
2	I		I				I–3	C
3	I	I	NI	I	I	NI	NI	C
4	NI	I	I	NI	I	I	I	C
5	I	I	I	I	I	I	I–3	C
6	I	I	NI	NC	I	I	I	C
7	I	I	I	NI	PI	I	NC	C

There were two mini PBS systems due to the decision of the Scheduler teams from Sessions 6 and 7 to build the subsystems to which they interfaced (i.e., the Database, Navigator, and Tracker subsystems). When they realized that the PBS system could not be fully integrated, they simply enhanced their testing setup to make the demo more realistic. Session 3 was the only project that was completely driven by the supervisor, and that was the only session that decided not to try to fully integrate their PBS. They terminated their project during the second-last week of the semester. All other sessions asked for permission to work on weekends in the laboratory. Session 4 was only initially driven by the supervisor.

Surprisingly, the most difficult subsystems turned out to be the most complete, and team size did not become a negative factor. However, was the outcome as expected? In that respect, Table 2 may not give the right answer, if we assume that only a completed project is the proof of success. Our aim was not to make the project trivial so that it had to be completed. This project course required constant attention from the students. Their dedication was reflected in the high ratio of integrated subsystems. They managed to identify the critical requirements and design features, and, based on these, they put together and controlled a manageable project plan. Therefore, we conclude that the framework was balanced and effective, and that the project was interesting.

We repeatedly emphasized that a working prototype that does not match its requirements and design, or a working subsystem prototype that was developed in isolation, would not be appreciated. To achieve this, students had to keep documents up-to-date and could resubmit them. Each project had to produce the system requirements, system design, test plan, and a schedule, and each team had to do the same for their subsystem. These equate to, for example, six PBS subsystem requirements and one PBS system requirement, and one Web Site requirements per project. Each student had to produce the object design document and a test plan for the code.

The templates, such as the one shown in Figure 2, are complex documents that have six or seven pages. For a project with 70 students, this adds up to about 160 documents. The resubmission rate for the requirements and system design was between 1.9 and 3. We believe that many problems were resolved through other means of communication rather than only through these documents. It was difficult to estimate the exact rate for the object design documents because the versions were not clearly and consistently marked by the authors. Overall, there were between 700 and 900 documents and UML diagrams submitted per project, including code. All the code had to be submitted, too. These results clearly stood out in comparison with past laboratories and toy projects when the output was between 100 and 200 pages for the same number of students per laboratory.

Most students demonstrated good time management skills, but some experienced difficulties in taking into consideration the dynamics of the project as a whole. Sharing and working on such a large scale was beyond their experience, just as it was new to the university. Among the 49 teams only two can be described as problematic (i.e., Tracker 7, and Navigator 6). One of them clearly lacked motivation and the other constantly struggled. Both teams failed to interact with other teams in the project.

Three database teams did not initially perform well, mainly because the requirements were unstable or did not exist. When the students realized that they had to repeatedly speculate and modify parts of their work products, they decided not to follow in step. In the end, there was not enough time for two teams to fully complete and integrate their work. This could be a good indicator of how they perceived their own mistakes as opposed to those committed by other students and teams. Rework has been recognized as a systemic problem [Osborne 1993], and it came as no surprise that this course revealed similar patterns.

In contrast, all the City Map Editors were completed, and some were surprisingly flexible. For example, a street that intersects other streets could have its parts individually selected and moved, and that part could dynamically adjust its size. This situation presented a dilemma to the supervisor. Clearly, the students were enjoying their experimentation, but they also stalled the progress of other teams. Rather than imposing a decision upon them, the supervisor tried to involve the teams together in order to narrow down the problem space, and they all became more confident about how to proceed. A similar dilemma rose with Java 3D because some students in the Tracker teams did not realize it, so they worked on the graphical images and models. However, as mentioned below, this engagement opened up unexpected UML questions.

One Setup team started with seven participants but shrank by one after the midterm break. However, they still managed to produce about 260 pages of quality documentation, and the best Setup subsystem, while losing two periods due to public holidays. Overall, our goal of improving the quality of work products other than code, as well as a much higher ratio of active participation, was certainly achieved.

The complaints that this kind of laboratory project required an extraordinary amount of learning aside from the course material prompted us to organize the two outstanding laboratory briefings. Given that, except for RMI, we did not introduce any new technology that had not been used in the past, we found these complaints and concerns an indicator of the broad commitment and participation. After the briefings, the complaints subsided.

On the flip side, new and surprising learning situations emerged. For example, the students who worked on the graphical images and models for their Trackers became concerned about UML. They stated that UML could not be used for the graphics as there were no attributes, behavior, and classes. Therefore, they could not produce any UML diagrams. However, the structure of a scene could be easily captured in UML. A scene consists of objects, such as a tree consists of branches, leaves, and trees. While there was no interaction between the objects in a still image, they could conceptually form an aggregation or a composition.

Students raised concerns towards the end of the semester about whether a project that failed to fully integrate would have a large negative impact on the final grade (60% for the individual effort, 40% for the team). The word they used was *punish*. The answer was that this laboratory project was all about learning, not punishing, and that there was enough flexibility to reward everybody according to their accomplishments.

In contrast, there was a strong sense of accomplishment and maturity among those students who managed to integrate their PBS. One ecstatic student summed up the excitement by stating: *This is incredible. We use machines from all over the lab, and our system is working!* But the fact they managed to pull it off was not incredible, it was expected.

CONCLUSION

Software systems are ever increasing in complexity, size, and number of features they support and technologies they use. They often require teams of professionals of varying profiles to build them with quality and within the shortest time possible. The aim of software engineering education should be to prepare students for the challenges of the workplace so that graduates can become productive participants from the very beginning of their professional careers. This includes deciding on appropriate technologies and tools, learning how to apply and use them, and understanding their purpose, limitations, and impact.

Team projects present participants with other challenges, such as communication, coordination, and planning, all of which are dynamic in nature and require much effort and time to overcome. As an engineering discipline, software engineering is not algorithmic and its problems are ill-structured. Software development projects require close control and management, constant attention to details, and making trade-offs based on the understanding of the problem and task at hand in all of its multiple dimensions. In this sense, real world projects and team-oriented student projects share similar prerequisites and problems.

CPE 207 has been prepared according to these findings and ideas, and it has focused only on one analysis and design method, i.e., the object-oriented method, since it is the de facto standard in the industry. Likewise, we opted for Java due to its versatility and wide adoption. CPE 207 engages the students' motivation and skills through a large project that is controllable, dynamic, formal, and relevant. The laboratory allows students to more thoroughly apply software engineering theory and experiment as it faithfully reveals the complexity and interdisciplinary nature of software development at a level that is appropriate for students' experience and knowledge.

Our approach has been tested over six projects in which the same problem statement and software architecture were used to build a unique PBS system each time. The size of the projects varied from 65 to 110 students. Surprisingly, the complexity of the project and the size of the team did not have a negative impact on the outcome either at the project or team levels. None of the projects sank or demonstrated an inclination towards giving up. All of these lead us to conclude that the amount of information presented and provided to the students by the laboratory manual, lectures, and tutorials was appropriate and sufficient. The outcome confirms that the students found the overall complexity of the project and working environment not only manageable but also motivational.

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Chapter 8

EXPANDING THE CLASSROOM CURRICULUM: INTEGRATING ACADEMIC AND SERVICE-LEARNING STANDARDS TO IMPROVE STUDENTS' ACADEMIC KNOWLEDGE AND INCREASE THEIR SOCIAL COMPETENCY

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ABSTRACT

Five years of service-learning data was explored for this mixed method study 1) describing the importance of integrating academic and social curriculum using subject area and service-learning standards and 2) analyzing the integrated service-learning projects by academic content, curriculum themes, service-learning types, impact on students. Total number of participants included 132 preservice teachers and 3500 students, prekindergarten to 2nd grade. Data for this chapter is comprised of the 129 consenting preservice teachers' service-learning lesson plans, questionnaires, and focus group interviews and 563 student responses, which represent five randomly chosen students from each participating classroom.

Qualitative analysis utilized a starter list of codes for the initial readings of questionnaires, lesson plans, and focus group interviews; rereading and interpretation of the codes was used to create categories of meaning; and finally the categories were transformed into meaningful data by searching for patterns, themes, and regularities as well as contrasts, paradoxes, and irregularities (Delamont, 1992). Quantitatively, the data was entered into SPSS to ascertain the relationship between grade level, type of service-learning project, and what social effect the service-learning project had on the students 3 months later. In addition, a crosstabulation was used to analyze the relationship between service-learning type and curriculum content.

The chapter provides a targeted review of literature describing curriculum standards, service-learning standards, and the rationale for integrating them in teacher education programs and P-12 schools. Findings discuss 1) why social studies and science were the most often integrated academic standards in the 120 lesson plans, 2) the five curriculum theme categories and, 3) the significant impact of the academic and social curriculum on students.

INTRODUCTION

School reform efforts, which emphasize tougher standards and accountability, have significantly influenced approaches to teaching and learning in our nations' classrooms. With The No Child Left Behind Act of 2001 (NCLB), the pendulum in education has swung away from active, hands-on learning towards more traditional approaches. Faced with increasing pressures to improve test scores and provide more intensive early intervention, teachers have adopted more didactic curriculum materials and pedagogical approaches. This shift has been especially difficult for teachers who strive to use experiential or constructivist approaches. As an instructional strategy however, service-learning allows teachers and teacher educators to meet the needs of students while at the same time teaching academic standards (Jacoby, 1996).

Imagine students planting a garden or drawing posters asking others not to litter. These are activities related to service-learning that integrate curriculum standards. Using experiential learning, service-learning aids students in connecting their school curriculum with their community at the same time increasing students academic ability. This chapter 1) describes the importance of integrating academic and social curriculum using subject area and service-learning standards, 2) analyzing five years of integrated service-learning projects by academic content, curriculum themes, service-learning types, impact on students.

CURRICULUM STANDARDS

Most professional organizations have established content standards for their corresponding discipline areas (e.g., International Reading Association [IRA], National Council for Teachers of English [NCTE], National Council of Teachers of Mathematics [NCTM], National Council for the Social Studies [NCSS], National Academies of Science, American Association for Health Education [AAHE], and Consortium of National Arts Education Associations). These diverse organizations follow similar methodologies in their approaches to teaching and learning, which were analyzed in *Best Practices: New Standards for Teaching and Learning in America's Schools* (Zemelman, Daniels, & Hyde, 1998). Table A1 outlines a selection of their teaching recommendations.

Best Practices draws attention to thirteen essential principles, assumptions, and theories that characterize good teaching and learning (Zemelman et al, 1998). Their analyses of the professional organizations illustrate that classrooms should be student-centered, experiential, holistic, authentic, expressive, reflective, social, collaborative, democratic, cognitive, developmental, constructivist, and challenging. These beliefs directly correspond to service-learning goals.

Typically, academic standards specify what students should know or be able to do and include content, performance, and proficiency descriptors. They require evidence that students have achieved or mastered the standards and to what degree. In order to achieve increased learning and understanding of the academic content, service-learning must be combined with specific subject matter in the school curriculum, match content standards, and utilize active or experiential learning (Billig, 2000). When service-learning is fully integrated with the curriculum, academic outcomes include improved learning of academic subject, better grades, and higher standardized test scores. To illustrate how curriculum standards can be taught through service-learning, connections between academic areas and service-learning is explained. However, to maximize the impact of service-learning on student achievement, several academic subjects should be integrated (Roberts, 2002).

Academic Standards

Language Arts/Reading

Beginning with language arts/reading, the IRA (1989) and NCTE (2004) have outlined many standards that are met in most service-learning projects. The infusion of service-learning with language arts/reading is a natural fit for most teachers. Service-learning includes planning and reflection, which are part of the writing process. Language arts/readings standards that directly relate to service-learning include:

(a) Reads a wide range of print/literature from many periods and for many purposes;
(b) Applies a wide range of strategies to comprehend, interpret and evaluate;
(c) Adjusts the use of spoken, written, and visual language;
(d) Employs a wide range of strategies as they write;
(e) Applies knowledge of language structure and conventions;
(f) Conducts research on issues and interests by generating ideas and questions, and
(g) Uses a variety of resources (IRA, 1989).

Through service-learning students write letters; read and gather information from a variety of books, magazines, encyclopedias, and newspapers; and participate in discussions and cooperative group work. When used in structured ways, service-learning allows teachers to integrate language arts/reading content to improve academic outcomes.

Mathematics

Service-learning projects also help students achieve mathematics standards. NCTM (n.d.) suggests that lessons connect mathematics to other subjects and the real world. Integrated service-learning and mathematics lessons aid students in developing number sense and spatial sense, understanding collection and organization of data, expanding pattern recognition, and developing the use of tables and graphs.

Science

There are many recommendations for teaching science that resemble components of service-learning. Science instruction should be based on active activities that include observation, reflection, application, hypothesizing, questioning, and problem solving (*How Students Learn*, 2005). Science standards that are most commonly met through service-learning are those in the Life Science category, which include understanding characteristics of organisms, life cycles of organisms, and understanding the environments in which the organisms live. However, earth science, physical science, and applied science or technology content can also be met through service-learning.

Social studies

Like language arts/reading, science, and mathematics service-learning connects with social studies content by emphasizing inquiry and problem solving regarding significant human issues. Through participation in social, political, and economic affairs students share a sense of responsibility for the welfare of their school and community; thus, strengthening their civic responsibility. NCSS (1994) divides social studies into five areas: civics, economics, geography, U.S. history, and world history. These areas play a major role in service-learning since projects involve serving the community, helping others, and citizenship.

Fine arts

It is common for service-learning projects to incorporate art. Many teachers find it effective to use art as a form of reflection. Through theatre, visual art, music, and dance students learn to be creative, expressive, and increase their physical and cognitive abilities (Zemelman et al, 1998). The National Standards of Art Education (n.d.) stress that students should learn to work with many forms of art, compare works of art, discuss meanings of art, and make connections between visual arts, other disciplines, and the real world.

Health

Integrating service-learning and health standards allows teachers to effectively teach health content and skills. The American Association for Health Education (n.d.) states that students should study concepts related to good health and disease prevention; health risks; effective interpersonal communication skills that enhance health; using goal setting and decision making to increase health; and advocating for personal, family, and community health.

Summary

Teaching academic standards through service-learning can be accomplished across grade levels and through all curriculum areas. Research has demonstrated that students who participated in service-learning scored higher on reading and mathematics standardized tests (Akujobi & Simmons, 1997); showed an increase in problem-solving skills, interest in academics, and motivation to learn (Stephens, 1995); had had larger gains in measures of school engagement and mathematics achievement (Melchior, 1999). When used appropriately, service-learning improves students' academic knowledge, skills, and increases their social competency.

Social Standards

According to the Character Education Partnership (CEP, n.d.), character education encourages essential core and universal values such as helpfulness, respect, responsibility, citizenship, caring, and honesty, which comprise the social curriculum in most schools. Understanding and practicing character education is accomplished through meaningful interactions in school and community. To further emphasize the relevant connection between service-learning and character education, CEP states that service-learning helps students develop practical knowledge and understanding of fairness, cooperation, and respect (Lickona, Schaps, & Lewis, 2007).

Additionally, *No Child Left Behind Act, 107th Congress (2001), Title V, Part D, subpart 3, section 5431* offers federal funding for character education programs. These programs include educating children about caring, citizenship, fairness, respect, and responsibility. Lickona (1991) outlines seven reasons why schools should emphasize character education.

1. It is the best way to make an enduring difference in the life of a student.
2. Done well, it improves academic achievement.
3. Many students are not getting strong character formation anywhere else.
4. It prepares students to respect others and live in a diverse society.
5. It goes to the root of a range of social-moral problems, including incivility, dishonesty, violence, premature sexual activity, and a poor work ethic.
6. It is the best preparation for the workplace.
7. Teaching the values of the culture is the work of civilization.

Lickona argues that students should become *aware* of problems facing their community, country, or world; behave responsibly; and *perform* caring deeds. “Simply learning about the value of caring may increase students’ moral knowledge. But it won’t necessarily develop their own commitment to that value, their confidence that they themselves can help, or the skills needed to help effectively” (p. 312).

The emerging body of research suggests that when service-learning is used an instructional strategy, it allows teachers to integrate their academic and social curriculums. Service-learning strengthens students’ academic achievement and increases their community involvement, thus improving students’ school success.

SERVICE-LEARNING

During the past two decades there has been increasing federal support for service-learning. The National Center for Education Statistics (NCES) estimated that more than 13 million students were involved in service and service-learning projects during the 2000-2001 academic year (Learn & Serve Clearinghouse, n.d.a). More recently, 1,847 principals of K-12 public schools responded to a survey on the pervasiveness of service-learning in their schools. The National Study of the Prevalence of Community Service and Service-Learning in K-12 Public Schools collected data on the scope, policies, and support for service-learning provided by schools during the 2007-08 academic year (Corporation for National & Community

Service, 2008). The report stated that service-learning had risen from 64% in 1998 to 68% in 2008. High schools offered more service-learning opportunities (35%), compared to middle schools (25%) and elementary schools (20%). However, a majority of schools (74%) stated that they had no service-learning support from their district.

Definitions

While the number of students involved in service-learning has increased, there is still variation in what exactly service-learning is. However, several critical components have been agreed upon by most service-learning organizations.

Learn and serve america

Learn and Serve America supports and encourages service-learning throughout the United States and enables over one million students to make meaningful contributions to their community while building their academic and civic skills. They provide direct and indirect support to K-12 schools, community groups, and higher education institutions to facilitate service-learning projects. Learn and Serve defines service-learning as combining service objectives and learning objectives with the intent that the activity change both the recipient and the provider of the service (Learn & Serve Clearinghouse, n.d.).

National and community service trust act

According to the National and Community Service Trust Act of 1993 (NCSTA, p. 59), the term service-learning means a method:

(A) under which students learn and develop through active participation in thoughtfully organized service that-
- (i) is conducted in and meets the needs of a community;
- (ii) is coordinated with an elementary school, secondary school, institution of higher education, or community service program, and with the community; and
- (iii) helps foster civic responsibility; and

(B) that—
- (i) is integrated into and enhances the academic curriculum of the students, or the educational components of the community service program in which the participants are enrolled; and
- (ii) provides structured time for the students or participants to reflect on the service experience.

Alliance for service-learning in education reform

The Alliance for Service-Learning in Education Reform (ASLER, 1993) provides high quality standards of service-learning projects using a model that includes assessing, evaluating, reporting, and completing. ASLER defines service-learning as a method by which young people learn and develop the content standards through active participation in thoughtfully-organized service experiences.

No matter the grade level or subject area taught, service-learning is applicable. One student, a group of students, a classroom, or the whole school can be involved in service-learning. The thread that connects the definitions of service-learning is that students are engaged in the educational process through the application of academic standards to real-life learning situations.

Service-Learning Standards

What many educators do no realize is that there are service-learning standards. These standards, revised in 2008, were developed in the same way most states develop their curriculum standards. Utilizing extensive research and experts in the field, an initial group of service-learning standards and indicators were developed. Then, 21 vetting panels helped revise and modify them until the final version of 8 standards and 35 indicators were agreed upon. The eight standards include (National Youth Leadership Council, 2008):

Meaningful Service: Service-learning actively engages participants in meaningful and personally relevant service activities.

Link to Curriculum: Service-learning is intentionally used as an instructional strategy to meet learning goals and/or content standards.

Reflection**:** Service-learning incorporates multiple challenging reflection activities that are ongoing and that prompt deep thinking and analysis about oneself and one's relationship to society.

Diversity: Service-learning promotes understanding of diversity and mutual respect among all participants.

Youth Voice: Service-learning provides youth with a strong voice in planning, implementing, and evaluating service-learning experiences with guidance from adults.

Partnerships: Service-learning partnerships are collaborative, mutually beneficial, and address community needs.

Progress Monitoring: Service-learning engages participants in an ongoing process to assess the quality of implementation and progress toward meeting specified goals, and uses results for improvement and sustainability.

Duration and Intensity: Service-learning has sufficient duration and intensity to address community needs and meet specified outcomes.

As comprehensive as the standards are, aligning them with academic standards is the teacher's responsibility. Whether it is through preservice teacher education, in-service trainings, or making teachers aware of these standards through other means, we feel it is critical that non-traditional pedagogy inculcate academic standards and service-learning standards.

Types of Service-Learning

Service-learning is divided into four different approaches (Kaye 2004). *Direct Service* means the interaction is person-to-person or face-to-face. Examples include field trips to visit a retirement center or hospital, or cross-grade tutoring or mentoring. *Indirect Service* on the other hand, provides service to the community but not to an individual. Projects might include planting a garden, writing letters, or drawing cards for the troops. Creating awareness of public interest issues is the focus of *Advocacy Service.* Students might be involved in making and posting *do not litter* signs for their playground. The last type of service-learning, *Research Service,* focuses on finding, gathering, and reporting information. When students produce a book after researching and interviewing people who performed heroic acts after a local disaster, they are involved in research service.

Of the four types of service-learning described, preschool and primary students should be involved in direct service-learning. As preoperational thinkers, these students benefit from concrete experiences that focus on only one dimension of an event. Direct service-learning has a greater impact on students if they have face-to-face, thus receive immediate feedback. As students become concrete and abstract thinkers, they can be involved in planning and implementing all four types of service-learning. Older students are more capable of classifying objects and events, asking and answering *what if* questions, and thinking abstractly. However, the type of service-learning should always compliment and extend the academic content, as well as match the developmental needs of the students involved.

Community

The concept of *community* is a central component of service-learning and is described in two ways: geographically and socially (Kaye, 2004). How teachers portray community depends on the nature of the service-learning activity. For example, in the context of P-6 education, community is classified as one or more classrooms, or the entire school. Older students, fourth grade and beyond, are able to grasp a broader definition of community: school campus, town or city they live in, or globally. Kaye states that, “Through service-learning, the often elusive idea of ‘community’ takes shape and has a more tangible meaning for all involved” (p. 8).

Summary

With 74% of schools surveyed stating that they did not receive any service-learning support from their district (Corporation for National & Community Service, 2008), it is crucial that service-learning pedagogy be expanded in P-12 schools as well as institutions of higher education. Both preservice and in-service teachers should be actively encouraged to implement service-learning as an instructional strategy that teaches both academic and social standards and increases students’ academic success.

Cochran-Smith and Lyttle’s (1999) *knowledge-of-practice* is one model used with preservice and in-service teachers to teach service-learning. Knowledge-of-practice views teacher education as developmental. Therefore, evidence-based practices are taught sequentially by having the teachers: 1) learn the theoretical rationale, 2) see service-learning practices modeled, 3) apply service-learning practices and receive coaching with feedback and guidance, and 4) reflect on the impact of service-learning.

METHODOLOGY

Program Overview

Over the past five years, our university teacher education program, located at a large research university in the southeastern United States and the local school district have been collaborating on service-learning. The structure of our program requires a large amount of time in field-based classrooms. In March of their sophomore year, approximately 60-80 preservice teacher candidates apply to the early childhood program; thirty applicants are selected and admitted to the program for the following fall semester. Once admitted, the preservice teachers' classes are sequenced and they travel together as a cohort for the next four semesters, or blocks, until graduation. The PSTs are made aware that they were accepted into a program that integrates academic content and service-learning using a cascading knowledge-of-practice model.

A cascading knowledge-of-practice service-learning model is one where the teacher educators teach service-learning pedagogy to the PSTs who are actively involved using service-learning in local schools. The PSTs then teach service-learning to the students in their field placement classrooms via the implementation of service-learning projects. Subsequently, the students teach others about service-learning through their community efforts. The integrated cascading approach offers students an opportunity to learn in a way that is most natural to them, as opposed to a segmented approach stressing isolated skills and concepts (Verducci & Pope, 2001). This model aligns itself with the national reform efforts that emphasize curriculum restructuring (see Table A1) and establishes even closer links between curriculum and community.

Participants

Total number of service-learning participants included 132 preservice teachers and 3500 students, prekindergarten to 2nd grade. Data for this chapter is comprised of the 129 consenting preservice teachers' service-learning lesson plans, questionnaires, and focus group interviews and 563 student responses, which represent five randomly chosen students from each participating classroom. Preservice teacher demographic breakdown: 3 males, 126 females, 115 Caucasian, 7 African Americans, 6 Hispanic Americans, 2 Indian Americans. Student demographic data was incomplete so is not reported.

Procedures

At the end of the spring and fall semesters, all the PSTs provided copies of their service-learning lesson plans that included content and social standards, photos and/or artifacts, self-evaluations (Appendix B), and student evaluations (Appendix C). The evaluation instrument used the first year was deemed too vague, so it was replaced. Starting with the 2005 cohort, the PSTs responded in writing to 11 questions targeting the effectiveness of their projects; concepts and skills taught; student's academic and social benefits of participating in the project; how the project supported the state standards; and the specific products of the projects.

Using a structured questionnaire, data was also collected from five randomly selected students (Appendix C). However, each PST interviewed students in another PST's classroom thereby reducing *teacher pleasing* answers (Greig, Taylor, & MacKay, 2007).

Qualitative

PSTs were required to identify the state standards, social skills, and service-learning standards in their lesson plans. A doctoral student with service-learning background identified and counted the standards in each lesson plan. Every 10th lesson plan was then reviewed by one of the authors. Reliability was 100% for the content and service-learning standards. The social skills were more complicated to determine reliability because many of the skills are so closely related. For example, one coder identified a social skill as sharing (materials) and the second coder identified the same skill as being helpful (providing materials to a friend). Social reliability ranged from 95% - 100%.

The service-learning lesson plans were analyzed and coded for curricular themes with similar categories merged. If lesson plans fit in more than one category, the authors made the category decision. Each lesson plan represents only one category.

Focus group interviews, conducted at the end of each semester, asked the PSTs to discuss the type of service-learning implemented. These interviews were transcribed, coded, analyzed, and triangulated with the emerging results (Hatch, 2007).

Quantitative

The PSTs lesson plans and student responses were coded by the two authors. Student responses were analyzed using SPSS to determine the impact of the service-learning projects at their schools. Specifically, we wanted to know what content knowledge the students had learned through their service-learning projects. The data analysis was performed using simple crosstabulations and frequencies (see Tables A3 & A4).

FINDINGS AND DISCUSSION

Academic Standards and Service-learning

Knowing that it is the teacher's responsibility to integrate the academic and service-learning standards, lesson plans were examined for both content and social objectives, type of service-learning, and the number of academic objectives included in each plan. Table A3 outlines academic objectives included within the service-learning curriculum themes.

Social studies and science, Approximately 60% of the service-learning projects integrated social studies and/or science standards. Since service-learning connects academic learning with the community, the large number of social studies integrated plans was expected. In fact, we thought there would be more even more lessons incorporating social studies standards. We were not surprised by the total number of service-learning projects that incorporated science standards in the lesson plans. Many of the service-learning projects involved beach clean up, gardening, school beautification, so many of the PSTs naturally fit science standards into these projects.

Language arts/reading. Our partner school district currently uses a direct instruction language arts/reading curriculum that reinforces the *traditional* practices from Table A1– whole class, teacher directed instruction; rote memorization; and one-way transmission of knowledge (Zemelman et al, 1998). However, 48% of the lesson plans integrated language arts/reading standards using active learning, not traditional teaching practices. One reason active learning occurred could be due to the developmental nature of the cascading knowledge-of-practice service-learning model. If we only incorporated service-learning in one Block or semester, the PSTs might not have been capable of integrating language arts/reading and service-learning standards into active lessons. Because service-learning is integrated into almost all of their courses, modeled by their instructors, and the PSTs have to plan and teach a service-learning project each semester, they were able to move beyond traditional teaching methodology.

Mathematics. As happy as we were to see the high frequency of integrating language arts/reading and service-learning standards, we were dismayed to see how few lesson plans, only 14%, integrated service-learning and mathematics. Given the active and experiential nature of mathematics the curriculum is a natural fit for service-learning. We can only speculate reasons for the lack of mathematics/service-learning combination. One possible explanation might be the level of math anxiety many of our PSTs experience. (One author of this chapter teaches the mathematics methods course.) At the beginning of the mathematics methods course, the PSTs are asked if they like math and if they are good at math. In the past five years, four of the five cohorts have had 50% or more students with high math anxiety. Each cohort has had at least four PSTs who claimed that they chose early childhood education because they were so fearful of the mathematics required to teach in intermediate, middle, or high school (Lake, Jones, & Degli, 2004).

Alternatively, it could be that our PSTs need more experience in math. Like the reading/language arts courses, the PSTs' university mathematics methods course is grounded in constructivist theory, but direct instruction is what most PSTs experience in their field classrooms. Our program requires one mathematics methods course, taken in Block III, compared to five reading/language arts courses spread throughout the program. Maybe the PSTs need an additional mathematics course in order to build up their confidence. Then again, the PSTs only take one science and social studies methods course and they did not appear to have any difficulty integrating those curriculum standards and service-learning. We do not know why there are so few mathematics/service-learning projects. The data has exposed an area of concern that the program will address.

Discussion. As Table A3 illustrates, more than half of the service-learning plans integrated social studies or science standards. Since one of the goals of service-learning is community connection, the number of social studies lessons was expected, even a little low. We thought there would be an even amount of service-learning science and mathematics plans. As previously stated, we were correct in our assumption regarding science but incorrect about mathematics. As the themes revealed, science and social studies were the most common academic themes, but we still believe our PSTs could have done a better job at integrating mathematics into the service-learning activities. The unexpected finding was the high percentage of language arts/reading service-learning plans. It is common for elementary schools in our district to spend 90-120 minutes a day on traditional reading instruction. The PSTs were able to incorporate active literacy content experiences in lieu of some of the traditional lessons and/or the lessons were in addition to the already existing lessons.

Curriculum Themes and Service-Learning

When analyzing the lesson plans for the most frequent curriculum themes, projects that focused on helping others were the most common followed by recycling/pollution, letter writing, endangered species, and gardening.

Helping others

Helping others in need, who are less fortunate, or have limited community resources were the focus of 33% of the lesson plans. These projects included food and/or clothes drives (social studies, math, social), children in hospitals (health, science, social), autism awareness (social, health), hurricane relief (social studies, science, social), and cancer awareness (health, social, science) to name a few. Students were exposed to people who had experienced unfortunate circumstances, who were different from them in some way, or who were ill. In many cases, students learned about the differences of a child or children in their own classroom or school community. Helping others analysis revealed that 57% of the objectives targeted science, 37% social studies, 28% language arts/reading, and 14% math.

Pollution and recycling

Twenty two percent of the projects focused on the effects of pollution on humans, animals, and the earth while also studying recycling as a green solution. Objectives for this theme were concentrated in three academic areas: science (32%), social studies (31%), and language arts/reading (25%). Active learning activities included making classroom or school recycling bins (science, social studies, social), sorting recycling materials (math, science), beach clean up (social studies, science, social), sensory sorting (math, science) and school clean up (language arts, science, art, social). Students also raised environmental awareness via posters.

Letter writing

Approximately a quarter of the projects (22%) were letter writing projects to troops, local farmers, the Governor, President, students' grandparents, or other children. Half of these projects integrated clear language arts/reading standards such as dictating, drawing, writing for a purpose, writing for a variety of audiences, and using adjectives along with additional content standards reflecting the focus of the service-learning project. The other half utilized language arts/reading as a tool, but they did not focus on specific objectives. One semester several classrooms focused on writing persuasive letters to the Governor advising him to change the state's watershed legislation. Thus, integrating service-learning and science, social studies, and language arts/reading standards are all well within the scope of all teachers wanting to participate in service-learning. As expected, almost half of the academic objectives were language arts/reading.

Endangered species

Only 10% of the projects focused on endangered animals, their habitats, reasons why animals were losing their homes, and what the students could do to help. As most teachers realize, lessons that deal with animals connect and motivate many students. These projects encouraged the students to be involved through a variety of active learning strategies such as: making posters about the contributions of bats (science); drawing pictures of endangered species losing their habitats (science, social studies); acting out the loss of the rainforest (the arts, science, social studies); and using language to tell their schools, community, and families about sharks (language arts/reading, science). Traditional teaching methods, collecting food for the preservation of homeless cats and dogs (social studies, health), were also used. This theme had the highest concentration of math objectives (21%), followed by science (15%), and language arts/reading (12%).

Gardening

The least frequent (5%) service-learning curriculum theme was gardening. Activities focused on the use of senses-digging, measuring, observing, and planting (science); using clay pots as an artistic medium (art); growing and/or potting plants or flowers to give to others in need (science, social studies); and class and campus beatification (social studies). Science objectives were dominant in this curriculum theme (8%).

Discussion

Every semester most service-learning themes extended the classroom curriculum, however some themes mirrored current community or regional events. The data revealed a correlation between the time of year and the service-learning theme. Many spring projects centered on pollution and gardening, which are typical spring themes in elementary schools. While the fall projects, which occurred in November, were influenced by Thanksgiving concepts and environmental awareness. Examples of service-learning themes that reflected current events include providing relief for victims of the four hurricanes that hit the southeastern region of the US in late summer/early fall 2004 and working with the American Cancer Society to raise awareness and money for cancer victims and their families.

Types of Service-Learning

Although we taught the PSTs about the developmental appropriateness related to the four types of service-learning, most of the projects were indirect (see Table A3). As an early childhood program, direct service-learning is the most appropriate type for preoperational and concrete thinkers who benefit most from concrete experiences. For several PSTs, safety and budget concerns limited their ability to implement a direct project because they were unable to walk their students to the hospital, nursing home, lake, or park.

Indirect. Seventy percent of all the service-learning projects were indirect. When analyzed by curriculum themes, 40% were from helping others less fortunate, 29% from letter writing, and the other 31% were divided among the other curriculum areas. Helping others and letter writing are typical indirect service-learning projects. The PSTs were not allowed to take their students to the homeless shelter so collecting cans, food, and clothing was the next best thing. Crosstabulation analysis showed the indirect service-learning projects emphasized social studies (43%), language arts/reading (40%), and science (37%) standards.

Direct. Only 20% of the projects over the five years were direct service-learning with half of these focusing on recycling/pollution. Many students were involved in cleaning up their school, park, or local beach and creating recycling containers. Although some of the projects did not involve face-to-face interactions, the students received immediate feedback through their efforts so they could experience the impact of their involvement in the community. Crosstabulation results indicated that direct service-learning projects integrated mostly social studies (75%) and science (71%) standards.

Advocacy and research. Sixteen percent of all projects were advocacy. Endangered species accounted for most (59%) of the advocacy service-learning projects. There was one research project related to gardening. Crosstabulation analysis revealed that PSTs who implemented advocacy service-learning projects included science objectives 84% of the time.

Discussion

Focus group interviews revealed that every semester PSTs stated that they should have implemented a direct service-learning project. Maria (2008 cohort) shared that her students believed that every whale they saw on television or in a book was their adopted whale. Although her students mastered both the content and social curriculum standards, she felt that the impact on the students would have been greater had her project been direct service-learning. Specifically with the advocacy and research projects, PSTs commented that their students had difficulty connecting the classroom activities to the actual community need.

Research tells us that service-learning helps students make meaningful contributions to their community while building academic and social skills (Learn & Serve Clearinghouse, n.d.). However, teachers really need to match the type of service-learning to the developmental level of their students in order to maximize the academic and social impact, thus making the most of their curriculum.

Impact of Service-Learning on Curriculum

Academic content

To determine the academic impact of service-learning on the students, their responses were analyzed into three categories (Table A4):

Did the student express a learning comment/give specific feedback
Did the student express a social comment
Did the student express a non-learning comment/did not respond

The specific question analyzed was, “What did you learn from this project that you did not know before?” Answers ranged from “I didn’t learn anything” to “In the night sky, the part of the moon we see is the part lit by the sun.”

A majority of the responses, 60%, indicated that the students had learned the planned content objectives. The students’ answers included, “Veterans are people who fought in a war and did not die and came back because they did not die in the war. Some might have died though; I learned about all the different materials blind people need.” Additionally, 24% of the students provided a positive, social response to the question demonstrating the community or social impact of the projects. For example, “Service-learning is helping other people; I learned that our little hands can make a big difference to someone.”

Not all responses demonstrated content and/or social impact. Seventeen percent of the students stated that they did not learn anything from the project. “I didn’t learn anything. I already knew that sweets were bad.” or their answer did not relate to the question asked, “I learned to get a lollipop.”

Social content

Since helping others in the community is a focus of service-learning, the students were asked to describe helpful behaviors or acts they had exhibited since participating in the service-learning projects. Overwhelmingly the students provided very specific answers to this question, “Service-learning is helping other people; I learned that our little hands can make a big difference to someone.” When this question was analyzed, five categories emerged from the responses: family, community/society, school, the environment, and nothing/no answer (Table A5).

Family. Thirty-four percent of all the students interviewed gave examples of how they had helped a family member. The responses ranged from, “I helped my mom cook” to, “I helped my dad ride bikes. I helped him not feel lonely.” Both of these students participated in service-learning food drive projects and were able to transfer their feelings of empathy and caring to their family.

Community/Society. Approximately 21% of the students stated that they continued to *work* in their community. One student explained how he, “Helped [his] neighbor, helped people walk, gave to those less fortunate,” while another student from the same service-learning project recounted how she “Got clothes for them [people in need] so they have something to wear.”

Environment. Several students, 18%, told how they continued to protect the environment. “I don’t throw my paper away, I recycle it” reported one student. Another said that he had written a letter to the President asking him to stop cutting down the rain forest. “If we tell everyone to stop cutting down trees it will help, because if we don’t, we won’t have any rain forests and the whole world will be a desert.”

School. Thirteen percent of the responses transferred skills from their service-learning projects to their school community. One student stated, “If you are nice to people, they are nice to you. If people are mean to you don’t be mean back, tell the teacher.”

Nothing. Not all responses to this question yielded a social impact. Approximately 14% of students stated that they had not done anything helpful (or did not respond) since participating in their service-learning projects. This category also includes the students who said, "I can't remember" or "I don't know."

Discussion

Incredibly, 83% of the student responses expressed either the academic or the social objective of the service-learning. Many of the social content responses provided examples of helpful behaviors or acts. Even several months after the completion of the projects, students related to the social curriculum taught through service-learning. Can we say conclusively that student responses were directly related to their service-learning participation? No, we cannot. However, when each student's response was crosstabulated with the PST's lessons plan, the response matched the stated objective of the service-learning project. Therefore, we believe that these students were transferring the academic and social content learned through their participation in service-learning to their lives. As one student passionately stated, "Recycling saves the world, I learned that!"

CONCLUSIONS

This chapter described how curriculum could be taught through service-learning, examined five years of integrated service-learning projects for academic content, service-learning types, and impact on students. The data demonstrated the positive impact of service-learning on preservice teachers and students. This positive impact ultimately leads to the development of leaders who have initiative, know how to problem solve, and value teamwork (Bringle, Phillips, & Hudson 2004; Howard 2003). Through service-learning all learners gain a deeper understanding of themselves, their school and community, and society (Kaye, 2004).

Integrating the academic curriculum with benefits students by providing them with practice in both content and social curriculum through the use of active learning, exploration of interests, civic responsibility, character building, and recognizing and helping the community. These practices, established by national education organizations, strongly resemble the National Research Panel's *How Students Learn* (2005) and *How People Learn* (1999) outlining the importance of combining academic curriculum with service-learning goals. Research indicates that there is a positive relationship between service-learning and academic growth, specifically in students' academic engagement, attendance, and time on task (Billig, Root, & Jesse, 2005; Root, 1997).

Analyzing the service-learning lesson plans (Tables A3 & A4) confirmed that service-learning provides an alternative way to meet academic standards using non-traditional teaching approaches (Zemelman et al, 1998). Many school curriculums, which emphasize a more traditional approach of drill and practice of isolated skills, do not reflect current knowledge of human learning and brain development and fail to produce students who possess higher-order thinking and problem-solving abilities needed in society today (*How Students Learn,* 2005).

Service-learning has become a strategy in which many of our PSTs teach active and experiential lessons rather than the traditional direct pedagogy, which is more prominent in our school district. Additionally, in the last five years, several cooperating teachers have adopted a service-learning focus for their classrooms. These teachers have shared with us that service-learning has become a *backdoor approach* to implementing best practices. They report that service-learning has such a positive image, coupled with high parental/community involvement, that administrators are supportive of their efforts. Several teachers even list service-learning as part of their differentiated instruction plans. Service-learning, as an alternative teaching pedagogy, aids in the development and progress of all students. Students do learn in traditional settings, however as our research indicates, students thought service-learning lessons were *better* and more *fun* than their traditional lessons.

Data from the five years of service-learning lessons provided information on academic content and curriculum themes. Social studies and science were the most frequent content areas taught through service-learning, yet all academic areas were represented. While there are several helpful websites and books that include service-learning lesson plans, it is the teacher's responsibility to connect academic and service-learning standards for the activity to be meaningful for students. Although the use of service-learning has increased 4% from 1998 to 2008 (Corporation for National & Community Service, 2008), many educators still view service-learning as an *addition to* the regular curriculum or a *supplemental* teaching strategy. Through either pre-service or in-service training, teachers need models on integrating service-learning into the curriculum and information on how implementing service-learning teaches academic content.

In our focus group interviews, the PSTs were asked if they would continue to use service-learning as an instructional approach. All but one PST said yes. The one PST who said no stated that she was going into school counseling and was not planning to be a classroom teacher but that she hoped to support classroom teachers if they utilized service-learning. Therefore, our cascading model of service-learning, following the knowledge-of-practice model (Cochran-Smith & Lytle, 1999) has had a great impact on our preservice teachers and the future of service-learning in schools. Graduates of our program will become leaders as the national education priorities, outlined by the Obama-Biden plan for education (Service-learning United, 2008), seek to implement systematic service-learning in K-12 schools and higher education.

Implications

The focus of our cascading model of integrating teacher education curriculum and service-learning is one approach of modeling *best practices* for future teachers (Zemelman et al, 1998). Findings from our study have clear implications for all teacher education programs, as well as P-12 schools.

Working with a school district and classroom teachers presents challenges. Teachers, who did not understand that service-learning teaches and/or reinforces curriculum standards, will sometimes relegate service-learning as a non-academic or fun activity. Therefore, sharing the impact of service-learning on academic gains will help convince districts, schools, and teachers that service-learning belongs in their educational setting. We found that emphasizing the community aspects of service-learning allowed us entry into classrooms. When service-learning was first discussed with our partner schools we stressed the active learning and experiential learning aspects. We met with resistance. Therefore, our talking points changed to focus on the community aspects of service-learning; teachers and schools were much more receptive.

Recommendation: When approaching a school district, school, or individual classroom, examine their mission statement and/or school improvement plan. Then match your language to the language of the established goals.

It is our hope that, in their future classrooms, the PSTs match the service-learning projects to the developmental needs of their students. Although our data demonstrated that the service-learning projects positively affected students both academically and socially, we believe that they could have had a greater impact had they been direct service-learning. Our plan, as early childhood teacher educators, will be to scaffold the PSTs more on matching the developmental needs of students and the type of service-learning, so direct projects will increase.

Recommendation: When teachers first try service-learning, do not emphasize which type to use. However, after they implement service-learning once, provide support and guidance on matching the service-learning type to their students' developmental needs.

Our data revels that social studies, science, and language arts/reading content are the most common academic areas taught through service-learning. We have speculated on reasons why mathematics was not. Our program is addressing this issue by adding additional information and modeling for the PSTs on ways to include mathematics objectives in their service-learning lesson plans.

Recommendation: Teachers should record academic content taught through service-learning to monitor which content areas they are integrating. Based on the data, teachers should make the appropriate adjustments by adding additional content areas or different content areas to future service-learning projects.

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Table A1. Professional Organization Recommendations for Best Practices

More	Less
• experiential, inductive, hands-on learning.	• whole class, teacher directed instruction
• active learning in the classroom, with all the attendant noise and movement of students doing, talking, and collaborating	• classroom time devoted to fill-in-the-blank worksheets, dittos, workbooks, and other "seatwork"
• emphasis on higher-order thinking; learning a field's key concepts and principles	• rote memorization of facts and details
• deep study of a smaller number of topics, so that students internalize the field's way of inquiry	• presentational, one way transmission of information from teacher to student
• responsibility transferred to students for their work: goal setting, record keeping, monitoring, sharing, exhibiting, and evaluating	• emphasis on competition and grades in school • use of and reliance on standardized tests
• cooperative, collaborative activity; developing the classroom as an interdependent community	

Table A2. Service-learning Activities Per Program Block

Block I	• PSTs plan and implement small group service-learning projects of their choice.
Block II	• Public school field placement for 1.5 days per week. • PSTs 1) teach their field placement students what service-learning is and, 2) plan and execute a service-learning project integrating the state standards and service-learning standards.
Block III	• Same public school field placement for 1.5 days per week. • PSTs 1) teach their new field placement students what service-learning is and, 2) plan and execute a different service-learning project integrating the state standards and service-learning standards.
Block IV	• Same public school field placement for student teaching. • Program seniors mentor the juniors who are designing and planning their first service-learning project with their field-based students.

Table A3. Crosstabulation of Curriculum Themes with Academic Standards and Types of Service-learning from Preservice Teachers' Lesson Plan

Theme	LA/ Reading	Science	Social Studies	Math	*Direct*	*Indirect*	*Advocacy*	*Research*
Helping Others (33%)	28%	25%	35%	57%	25%	40%	0%	0%
Recycling/Pollution (22%)	12%	32%	30%	14%	50%	17%	21%	0%
Letter Writing (22%)	46%	13%	15%	7%	0%	29%	11%	0%
Endangered Species (10%)	12%	15%	5%	21%	0%	5%	58%	0%
Gardening (5%)	0%	8%	1%	0%	8%	4%	0%	50%
Miscellaneous (8%)	2%	6%	14%	7%	17%	6%	11%	0%
Total Number of Lesson Plans (120)	57	71	74	14	24	28	19	1

Table A4. Percentages of Academic and Social Impact Responses by Students

Service-Learning Type	Academic Learning Comment	Social Learning Comment	No/Non-Learning Comment
Helping those less fortunate	28%	60%	51%
Letter writing	21%	28%	20%
Pollution/Recycling	26%	1%	10%
Gardening	4%	2%	0%
Endangered Species	10%	0%	4%
Miscellaneous	11%	9%	14%

Table A 5. Breakdown of the 563 Student Social Curriculum Responses to "What other things have you done to be helpful since working on your project?" by Curriculum Theme

Service-Learning Project							
	Letter Writing	Gardening	Helping Those Less Fortunate	Endangered Species	Miscellaneous	Pollution/ Recycling	Total
Helped at School	2%	2%	2%	3%	1%	3%	13%
Helped at Home/Family	11%	3%	8%	6%	4%	2%	34%
Helped the Environment	>1%	3%	2%	4%	1%	7%	18%
Helped the Community/Society	6%	1%	6%	3%	4%	1%	21%
Nothing/No Answer	3%	1%	3%	4%	2%	1%	14%

APPENDIX A: EVALUATION OF THE EARLY CHILDHOOD SERVICE-LEARNING PROJECTS PRESERVICE TEACHERS

Turn in a hard copy as well as upload the completed form to the appropriate Blackboard site.

1. Tell us about your Service-Learning Project (SLP).
2. Describe any involvement of community members or organization?
3. How effective was the SLP for your class?
4. How did your students (circle: P-K, K, K/1, 1, 2) benefit from the SLP?
5. What changes in student's knowledge and performance have occurred as a result of the SLP?
6. What changes in students' attitudes and behavior have occurred as a result of the SLP?
7. What changes in students' enthusiasm/motivation have occurred as a result of the SLP?
8. Describe any changes in the ways that students talk about their SLP or the subject area of their project.
9. Describe three specific student products and compare the quality of those products with other work by those students.
10. How did SLP support the Sunshine State Standards?
11. Are you planning to use SL in your own instruction?
12. What have been the major barriers to students participating in this SLP?

Appendix B: Evaluation of the Early Childhood Service-Learning Projects
P-K, K, K/1, 1, 2 Children

Turn in a hard copy as well as upload the completed form to the appropriate Blackboard site.

- Choose another pre-service teacher at your school to interview at least 5 children from your class
- Introduce yourself to your classmate's children
- Ask them the following questions and record their answers
- Confirm understanding and thank the children and mentor

1. Tell me about the _______ [name of service-learning] project.
2. What did you learn from this project that you didn't know before?
3. How was your project helpful?
4. How did your project help other people/animals/environment?
5. What other things have you done to be helpful since working on your project?
6. How did working on the [Service-learning project] compare to the rest of your school work?

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Chapter 9

THE EFFECT OF USING EXPOSITORY TEXT STRUCTURES AS A STRATEGY ON SUMMARIZATION SKILLS

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ABSTRACT

This study, conducted with 28 sixth-grade students, investigated the effect of a summarizing teaching program on summarizing skills. The students were grouped as proficient and less proficient students and were presented teaching activities of 8 hours. The aim of this study was to comparatively test the effect of a) giving summarizing education, b) giving expository text (problem solving) education in addition to summarizing education against giving no summarizing education. Three study groups were used in the study: A Control Group (Group C) who were given traditional education, and two experiment groups. Experiment Group 1 (Group E1) was given both summarizing and text structure education, and Experiment Group 2 (Group E2) was given summarizing education. The results of the study show the positive effect of the teaching program on the experiment groups. The groups who were given summarizing and text structure education were more successful than the ones given only summarizing education.

1. INTRODUCTION

Writing is a language skill which helps to represent language in textual form. Producing a written text depends on the information encoded in one's long term memory by diverse

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experiences. When producing a text, a writer repeatedly executes the **planning, translating** and **reviewing** processes. During the planning process, the writer generates his ideas, organizes these ideas and sets goals. He puts his ideas into words during the translating process, and while reviewing, he evaluates and revises (Flower and Hayes, 1981). Since summarizing a text is a kind of text production process, the same cognitive processes as in written text production operate while summarizing. Summarizing is the action of transforming a source text into a shorter new text within the directions of the source text, using background knowledge. The source text is taken as a basis in structuring the information relating to the summary. For this reason the first step while summarizing is to comprehend the source text in a correct way. Comprehending a text depends on reading skills. Some cognitive processes operate while reading a text.

During the reading process, two processes called micro and macro operating processes are executed by the reader to establish meaningful relations between the sentences (van Dijk and Kintsch, 1983). Micro structure constitutes the text basis used to reach the macro structure. Macro structure, on the other hand, constitutes the general meaning in the text.

The reader, when trying to reach the macro structure, uses the information in the micro structure. Three basic operations that operate on the micro structure are deletion, generalizing and construction. The reader deletes a proposition if it is not relevant with the previous one. The reader uses more generalizing concepts instead of some others in the text. The reader constructs the propositions which complete each other and constitutes a macro structured proposition.

To sum up, a reader who operates the aforementioned cognitive processes applies the following textual operations in order to summarize and construct the source text. The reader

- Specifies the thesis statement of the source text
- Identifies the supporting ideas
- Deletes trivia and redundancies
- Generalizes and reconstructs some ideas (Day, 1986; Nelson, et al.; 1992; Trzeciak and Mackey, 1994; Trabasso, Bouchard, 2002; Akyol, 2006)

As one can clearly infer from the information above, when summarizing a text, it is essential to reach the macro structure which coincides with finding the thesis statement. It is not possible to summarize a text without reaching its macro structure. So reaching the macro structure of a text by using cognitive processes such as deletion, generalizing and construction points out to both comprehension of the text, and construction of its summary in memory. Thus both the reader who reads with the aim of comprehending the text, and the reader who reads with the aim of summarizing the text have to use the same cognitive operations in order to reach the thesis statement of the text.

During a reading process, it is possible to say that structuring the summary of a text forces the reader to evaluate the comprehensibility of the text. It also forces the reader to organize the content of the text on macro level and distinguish between the important and unimportant information in the text (Macnamara, 2007).

Evaluating these within an educational framework, we can say the following about these cognitive processes: While they function, for the reader, as a strategy for comprehending the source text, they also function, for the student writer, as a strategy for producing summaries.

The reason the summarizing strategy can be used as both a comprehension and a summary text production strategy is that reading and writing skills have common properties.

These common properties show that summarizing as a teaching strategy has double skill effects, namely writing skills and reading comprehension skills. This property of summarizing leads to a broad range of studies on summarizing. These studies mostly comprise the effect of summarizing strategies on reading and writing skills within different variables such as different age groups, different mental capacities and text types or text structures.

In their study Nelson et al. (1992) observed the effect of strategies teaching summarizing skills on comprehending scientific texts. 5 primary school students who need special treatment participated in the study. It is a known scientific fact that students who need special treatment have a disadvantage in comprehending a text, thus summarizing a text when compared to others (Winograd, 1984). Actually, all students can be thought to need strategy education for improving their comprehension skills. In this context, the literature has plenty of studies testing to see if summarizing strategies as a reading comprehension strategy has effects on students (Rinehart et al., 1986; Casazza, 1992)

Besides these studies which show the positive effect of summarizing strategies on comprehension level, some studies also show summarizing strategies have an effect of improving memory (see; Ross & DiVesta, 1976; Garner, 1982; Rinehart et al. 1986; Wittrock & Alesandrini, 1990; Foos, 1995).

The studies above are related with the effect of summarizing on comprehension and memory with different study groups. Summarizing strategies are also used together with writing skills, aiming to improve summarizing abilities, by teaching summarizing rules as strategies. Studies such as Friend (2001), Hare and Borchart (1984) can be given as examples.

In his experimental study, Friend (2001) taught summarizing skills to 147 university students, by referring to van Dijk and Kintsch's (1983) text-processing theory. Hare & Borchart (1984) improved Brown and Day's (1983) summarizing rules and constructed a study aiming to teach these rules to high school students.

The studies mentioned until now are mostly about comprehension/remembering and producing summary texts. Apart from these studies, there are also studies on using and identifying the strategies used in producing summaries (Çıkrıkçı, 2004); comparing summarizing strategies with other strategies (King, 1992; Day, 1986); comparing the usage and the ability of summarizing strategies according to age groups (Cani, 1984; Rivard, 2001).

In his study, King (1992) compared summarizing strategies with note taking-review and self-questioning strategies. In a similar study, Day (1986) compared four different methods used in teaching summarizing skills. In their comparative study, Williams, Taylor and Cani (1984) observed the effect of extending the macrostructure for expository texts with contradictory information on third, fourth and seventh grade students and adults. Rivard (2001) compared summaries produced by FL1 and FL2 secondary students. Despite these comparative studies on summarizing strategies, the need for a study on integrating summarizing strategies with text structure strategies can clearly be observed. There are some studies aiming to fulfill this need in the literature. For instance, in their study, Armbuster et al. (1987) observed the effect of giving a direct text structure and summarizing education on comprehending problem/solving expository text structure with 82 fifth grade students. In this study, students were divided into two groups as control and experiment groups. Students in the experiment group were given summarizing education based on problem solving structure while students in the control group were given no education about summarizing skills.

Apart from these studies, research shows that students use some strategies in summarizing a source text. Students generally use deleting trivia or propositional expressions as a strategy. However, they rarely or never use strategies which require high level cognitive operations such as choosing a topic sentence, constructing a topic sentence, generalizing/constructing while transforming a source text (Garner, 1982; Çıkrıkçı, 2004). Generalizing/construction and structuring a topic sentence while summarizing are recognized as important strategies (Baumann, 1984; Wittrock & Alesandrini, 1990; Friend, 2001). As a natural result, problems in transforming the source text to summary emerge, as well as problems in comprehending the source text. The need for a program for the sake of developing these skills is required in literature.

We designed our study focusing on teaching summarizing strategies to students with different proficiency levels at the same ages. The level of less proficient students in reading and writing skills is expected to be lower. Since both skills are required while summarizing a text, failure in these language skills may result in different summarizing abilities. This study aims to examine the effect of both summary writing education and text structure education on summarizing skills on proficient and less proficient students.

In the light of the given theoretical knowledge, the aim of this study is to comparatively test the effect of

(a) giving summarizing education,
(b) giving expository text (problem solving) education as well as summarizing education against giving no summarizing education to students with different proficiency levels.

The following questions will be answered during the study applied with the mentioned experimental design and study group.

1. Is there a meaningful difference between the summarizing achievements of less proficient students?
2. Is there a meaningful difference between the summarizing achievements of proficient students?

2. Method

This study is an experimental study. Pre-test post-test experimental design was used in order to reach the answer to the questions given above. Three study groups were used in the study. These groups were named as the *Control Group (Group C)* who were given traditional education; *Experiment Group 1 (Group E1)* who were given both summarizing and text structure education and *Experiment Group 2 (Group E2)* who were given summarizing education. The information about the participants, materials and the procedure is given below.

2.1. Participants

Participants of the study were 28 6th grade Turkish students aged 12 attending Seyfi Demirsoy Primary School in Atakum, Samsun. All participants were Turkish native speakers. The students were divided into two groups concerning their pre-test scores as proficient and less proficient students. The success level of less proficient students in reading and writing skills are absolutely lower. The reason for dividing the students into two parties as less proficient and proficient students is to examine the effect of the teaching program on both proficiency groups with different reading and writing proficiency levels. 13 participants whose pre-test scores were 40 or less were assigned as less proficient students whereas 15 students whose pre-test scores were 75 or more were assigned as proficient students. Then these students were divided into three subgroups as Control, Experiment 1 and Experiment 2.

Among the less proficient students, 5 students were assigned to Control Group, 5 were assigned to Experiment 1 Group, and 3 were assigned to Experiment 2 Group. Among the proficient students, 5 students were assigned to Control Group, 5 were assigned to Experiment 1 Group, and 5 were assigned to Experiment 2 Group. The numbers and groups of the participants are shown in Table 1.

2.2. Procedure

Firstly, two texts which include daily topics were chosen as source texts for summarizing, which were constructed according to the problem solving structure. While choosing the expository texts to be used in pre-test and post-test, criteria such as average word number (9,8), average sentence number (28; 26), equality in reading period, number of unknown words, consistency of the topic with the students' background knowledge were taken into consideration. Following this step, experienced teachers were consulted concerning the listed criteria. Eventually, two texts titled "The Problem of Our Age: Environmental Pollution" and "Patience" were chosen as source texts. The text about environmental pollution was chosen to be used in pre-test as source text. The other text which is about patience was to be used in post-test.

As the second step, a measuring instrument based on summarizing and coherence rules was developed. Students' summaries were scored according to this measuring instrument (see App.1). These summaries were scored by 4 people two of whom were lecturers in Turkish Language Department at a university and the other two were Turkish teachers. Coefficient of correlation was taken into consideration while evaluating the coherence between the people who assessed the summaries. The correlation coefficient for pre-test and post-test was .98. This value shows the coherence between the readers. For this reason, all readers were asked to decide on a single score while assessing the summaries in pre-test and post-test.

Summarizing rules and coherence rules scores made up the pre-test summary writing scores. According to the findings of the pre-test, 5 students from C and E1, and 3 students from E2 who were equal in summarizing skills were chosen as less proficient students, where 5 students from C, E1 and E2 were chosen as proficient students.

After pre-test, the students were presented a teaching program with teaching activities (see; App. 2 & 3) prepared for each group. In his study, Garner (1984) asserts that teachers may not be competent enough in giving education on summarizing skills. Therefore, before presenting the teaching program, teachers who worked with the participants were given education on summarizing strategies, both concerning their possible inadequacy on the subject and the elimination of possible errors during the process. After this procedure, the teaching program was presented to the students by the help of these teachers.

Direct and student centered teaching methods were integrated during the application of the teaching program. This program included all summarizing strategies.

No special education was given to Group C. They were given a traditional education during this process. An integrated education on text structure and summarizing strategies was given to Group E1. Group E2 was only given education on summarizing skills. For these groups (E1 and E2) two teaching programs on achieving summarizing skills were prepared. Both programs included expository paragraph texts composed with 5-8 sentences and 40-70 words. The program prepared for Group E1 is shown in Appendix 3 and the program prepared for Group E2 is shown in Appendix 2.

After this procedure, post-test was applied and the students were asked to summarize the given texts in the exams. The same procedure is used both in pre-test and post-test.

After all these procedure, pre-test and post-test scores of proficient and less proficient students were compared and evaluated.

Table 1. The study groups of the study

	Control	*Experiment 1*	*Experiment 2*	Total
Less Proficient	5	5	3	13
Proficient	5	5	5	15

3. Findings and Results

3.1. Findings

The data analysis measured the average scores obtained by the control groups and the experimental groups on each of the tests. It also measured the amount of learning by comparing the pre-test scores with those on the post-test.

13 students were determined as less proficient students after summary writing pre-test applied to Groups C, E1 and E2. Summarizing rules, coherence rules and summary writing distribution of these less proficient students' mean scores are shown in Table 2.

13 students whose scores were 40 and less over 100 points were chosen. Of these 13 students, 5 were assigned to Group C, 5 were assigned to Group E1 and 3 were assigned to Group E2. Students are shown in Column 2. Their scores on summarizing rules, coherence rules and summary writing are shown on the other columns. As the numbers in summarizing rules and summary writing tests are not equal, Kruskal Wallis Test was used in order to analyze the differences between these groups. The equality of the numbers in Column 4 shows that students are at equal level considering their ability on applying coherence rules.

The results of the Kruskal Wallis Test for *summarizing rules* are shown in Table 3. Values in Table 3 [$X^2(2) = 3.2$, $p \geq .05$] indicate that there is no meaningful difference among groups C, E1 and E2. These values show that there is no statistical difference among the less proficient students in the study group in applying summarizing rules.

The results of the Kruskal Wallis Test for *summary writing skills* are shown in Table 4. Values shown in Table 4 [X^2 (2) = 3.2, p≥.05] indicate no meaningful difference between groups C, E1 and E2. These values signify no difference among the students in the study groups in summary writing. These results indicate that there is no significant difference among the less proficient students in applying summarizing rules, coherence rules and summary writing skills.

Proficient students constituted the other half of the study group. Pre-test results and statistical calculations of these findings are shown in Table 5. The results in Table 5 show the distribution of summarizing rules, coherence rules and summary writing skills of 15 proficient students in Groups C, E1 and E2.

Table 2. Pre-test Mean Scores of Less Proficient Students

Group	Student	Summarizing Rules Mean Scores	Coherence Rules Mean Scores	Writing Summary Mean Scores
C	Student 1	0.71	0.60	0.67
	Student 2	0.71	0.60	0.67
	Student 3	0.71	0.60	0.67
	Student 4	0.86	0.60	0.83
	Student 5	0.71	0.60	0.67
E1	Student 6	0.71	0.60	0.67
	Student 7	0.71	0.60	0.67
	Student 8	0.71	0.60	0.67
	Student 9	0.57	0.60	0.58
	Student 10	0.57	0.60	0.58
E2	Student 11	0.71	0.60	0.67
	Student 12	0.57	0.60	0.58
	Student 13	0.71	0.60	0.67

Table 3. Pre-test Kruskal Wallis Test for Summarizing Rules of Less Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful Difference
C	5	9	2	3.2	.194	No
E1	5	5.6				
E2	3	6				

Table 4. Pre-test Kruskal Wallis Test for Summary Writing of Less Proficient Students

Groups	n	Median	sd	X^2	P	Meaningful Difference
C	5	9	2	3.2	.194	No
E1	5	5.6				
E2	3	6				

Table 5. Pre-test Mean Scores of Proficient Students

Group	Student	Summarizing Rules Mean Scores	Coherence Rules Mean Scores	Writing Summary Mean Scores
C	Student 1	0.86	0.60	0.75
	Student 2	1.14	1.20	1.17
	Student 3	1.00	1.00	1.00
	Student 4	1.14	1.40	1.25
	Student 5	1.00	1.00	1.00
E1	Student 6	1.00	1.00	1.00
	Student 7	1.14	1.20	1.17
	Student 8	1.29	1.40	1.33
	Student 9	1.00	1.00	1.00
	Student 10	1.00	1.00	1.00
E2	Student 11	1.00	1.00	1.00
	Student 12	1.00	1.00	1.00
	Student 13	1.14	1.40	1.25
	Student 14	1.00	1.00	1.00
	Student 15	1.00	1.00	1.00

15 students whose scores were 75 and more from a test over 100 were chosen as proficient students. These 15 students were distributed to groups within groups of 5. Kruskal Wallis Test was used to identify the statistical difference between them. The results of this test are shown in Tables 6, 7 and 8.

When 15 proficient students' pre-test results for summarizing rules were compared, the values [X^2 (2) = .606, p≥.05] indicated no significant difference between Groups C, E1 and E2.

Coherence rules (Table 7) and summary writing results (Table 8) are shown below. Values in Table 7 [X^2 (2) = .238, p≥.05] and values in Table 8 [X^2 (2) = 3.9, p≥.05] indicated no significant difference between groups C, E1 and E2 both in applying coherence rules and summary writing skills.

Table 6. Pre-test Kruskal Wallis Test for Summarizing Rules of Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful difference
C	5	7.6	2	.606	.739	no
E1	5	9.1				
E2	5	7.3				

Table 7. Pre-test Kruskal Wallis Test for Coherence Rules of Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful difference
C	5	7.7	2	.238	.888	no
E1	5	8.7				
E2	5	7.6				

Table 8. Pre-test Kruskal Wallis Test for Summary Writing of Proficient Students

Groups	n	Median	sd	X^2	P	Meaningful difference
C	5	7.6	2	3.9	.823	no
E1	5	8.9				
E2	5	7.5				

Pre-test scores and Kruskal Wallis Test results indicated that proficient and less proficient students share common cognitive development levels. Post-test findings are presented below in order to show the effect of the teaching activities. These results are given in the tables below.

After teaching program, a summary writing post-test was applied to three groups. The distribution of 13 less proficient students in Groups C, E1 and E2 according to summarizing rules, coherence rules and summary writing skills are given in Table 9.

When Table 9 is analyzed, it is possible to observe different mean scores. This difference creates a need to test the mean scores between groups. Kruskal Wallis Test is used in order to identify the differences between the groups. The results of these tests are given in Table 10, 11 and 12.

Table 9. Post-test Mean Scores of Less Proficient Students

Group	Student	Summarizing Rules Mean Scores	Coherence Rules Mean Scores	Writing Summary Mean Scores
C	Student 1	0.71	0.60	0.67
	Student 2	0.71	0.60	0.67
	Student 3	0.71	0.60	0.67
	Student 4	0.71	0.60	0.67
	Student 5	0.86	0.60	0.75
E1	Student 6	1.00	0.60	0.83
	Student 7	1.00	1.00	1.00
	Student 8	0.71	0.80	0.75
	Student 9	0.86	0.60	0.75
	Student 10	0.86	1.20	1.00
E2	Student 11	0.71	0.60	0.67
	Student 12	0.71	0.80	0.75
	Student 13	0.57	0.60	0.58

Table 10. Post-test Kruskal Wallis Test for Summarizing Rules of Less Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful Difference
C	5	6	2	6.6	.37	D1/D2
E1	5	10				
E2	3	3.6				

Table 11. Post-test Kruskal Wallis Test for Coherence Rules of Less Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful Difference
C	5	5	2	4.1	125	no
E1	5	9.1				
E2	3	6.8				

Table 12. Post-test Kruskal Wallis Test for Summary Writing of Less Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful Difference
C	5	4.9	2	7.6	.22	yes
E1	5	10.6				
E2	3	4.5				

Values obtained from Kruskal Wallis Test [X^2 (2)= 6.6, p≤.05] indicate a significant difference between the groups in applying the summarizing rules. But these statistical results do not show two groups which differ in applying summarizing rules. For this reason, Mann Whitney U test is used in order to analyze the difference between these groups. The results of this test show that E1 and E2 differ (U=1.00, p≤.05) in applying summarizing rules.

Values in Table 11 [X^2 (2)= 4.1, p≥.05], indicate no significant difference in applying coherence rules after the teaching activities. So, no difference in applying coherence rules is identified whereas meaningful difference is identified in applying summarizing rules. However, when post-test results of summary writing skills, which include summarizing rules and coherence rules, are analyzed, a difference between groups is identified. These results are shown in Table 12.

Values in Table 12 [X^2 (2)= 7.6, p≤.05], prove this difference statistically. Mann Whitney U Test shows that the difference is between groups C-*E1*(U=1.00, p≤.05) and *D1-D2* (U=1.00, p≤.05).

The post-test results of 15 proficient students in groups C, E1 and E2 according to summarizing rules, coherence rules and summary writing are given in Table 13.

Distribution of the scores between groups C, E1 and E2 can be seen in Table 13. Results of Kruskal Wallis Test which is used to analyze the difference between these groups are given in Tables 14, 15 and 16.

Table 13. Post-test Mean Scores of Proficient Students

Group	Student	Summarizing Rules Mean Scores	Coherence Rules Mean Scores	Writing Summary Mean Scores
C	Student 1	1.29	1.40	1.33
	Student 2	1.00	1.40	1.17
	Student 3	1.00	1.00	1.00
	Student 4	1.14	1.40	1.25
	Student 5	1.00	1.00	1.00
E1	Student 6	1.71	2.20	1.92
	Student 7	1.86	2.20	2.00
	Student 8	2.57	3.00	2.75
	Student 9	1.86	2.20	2.00
	Student 10	1.71	2.20	1.92
E2	Student 11	1.29	1.40	1.33
	Student 12	1.71	2.20	1.83
	Student 13	2.00	2.00	2.08
	Student 14	1.86	2.00	1.92
	Student 15	1.86	2.00	1.92

Table 14. Post-test Kruskal Wallis Test for Summarizing Rules of Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful Difference
C	5	3.1	2	9.3	.009	yes
E1	5	10.8				
E2	5	10.1				

Table 15. Post-test Kruskal Wallis Test for Coherence Rules of Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful Difference
C	5	3.3	2	11.5	.003	yes
E1	5	12.6				
E2	5	8.1				

Table 16. Post-test Kruskal Wallis Test for Summary Writing of Proficient Students

Groups	n	Median	sd	X^2	p	Meaningful Difference
C	5	3.3	2	10.1	.006	yes
E1	5	11.8				
E2	5	9.1				

Values in Table 14 [X^2 (2)= 9.3, $p \leq .05$], indicate a significant difference between proficient students in applying summarizing rules. Mann Whitney U Test shows that these differences are between groups *C-E1* (U=.000, $p \leq .05$) and *C-E2* (U=.500, $p \leq .05$).

Table 15 shows how coherence rules are applied by proficient students among three groups. Values in Table 15 [X^2(2)= 11.5, $p \leq .05$], indicate statistical difference between groups in applying coherence rules. Mann Whitney U test shows that these difference is between groups *C-E1* (U=.000, p≤.05), *C-E2* (U=1.500, p≤.05) and *E1-E2* (U=2.000, p≤.05).

Since the difference in summarizing rules and coherence rules is identified between groups of proficient students, differences in their summary writing scores are expected.

Values in Table 16 [X^2 (2)= 11.5, p≤.05], indicate difference between groups. After Mann Whitney U test results, this difference is clearly seen between groups *C-E1* (U=.000, p≤.05) and *C-E2* (U=.500, p≤.05).

To summarize, these findings show that there is no significant difference between groups C, E1 and E2 when pre-test results of less proficient students are evaluated. The data collected from proficient students also indicate no meaningful difference between groups C, E1 and E2. So, pre-test results signify no meaningful difference between groups.

When summary writing skills of less proficient students are evaluated, statistical difference between groups C-E1, and groups E1-E2 is observed. When their summarizing rules scores are evaluated, difference between E1-E2 is present. No difference between groups C and E1 is identified when summarizing rules scores are evaluated. However, when their coherence rules mean scores are evaluated, no difference between groups is observed.

When summary writing skills of proficient students are evaluated, difference between both groups C-E1 and groups C-E2 is observed. When their use of summarizing rules is analyzed, common results are observed. Difference between groups C-E1 and groups C-E2 is identified. However, when their use of coherence rules is analyzed, difference between groups C-E1, groups C-E2 and groups E1-E2 can be observed.

3.2. Results

The results of this study, which aims to develop students' summary writing skills, put forward the positive effect of the teaching process presented in students' summary writing processes.

It is a well known fact that the level of reading and writing skills may possibly be worse in less proficient students. As both reading and writing skills are required in producing a summary, the level of proficient and less proficient students are expected to differ in summary writing. Pre-test scores show this difference clearly.

Pre-test results indicate that three study groups both in proficient and less proficient students, are at equal level in summarizing rules, coherence rules and summary writing skills which require the ability to use both rules. So, all the students within less proficient groups and within proficient groups show no significant difference among them. On the other hand, the results of the post-test applied in order to test the effect of the teaching activities indicate significant differences between the achievement levels of the students.

When post-test scores of less proficient students were evaluated, no significant difference between Group C, which was given no summarizing education, and Group E1, which was given summarizing and text structure education, was identified in applying summarizing rules. However, Group E2, which was given only summarizing education was less successful than Group E1. This shows that when summarizing rules are considered, the teaching program was not as effective as the integrated program on less proficient students.

There was no significant difference in applying coherence rules between three groups among less proficient students.

Summary writing scores, which involve the scores of coherence and summarizing rules are similar to the summarizing rules scores. Group E1 is more successful than groups C and E2. So, the program integrated with text structure is more effective in achieving summary writing skills. Thus, among less proficient students, Group E1 is more successful than both Group C and Group E2.

The summarizing rules results of the proficient groups show that students in Group E1 and Group E2 are more successful in applying these rules. No difference between Group E1 and Group E2 was identified. This shows that proficient learners in groups E1 and E2 were able to learn how to apply summarizing rules. So, both teaching programs were effective when applying summarizing rules was concerned.

There is a meaningful difference between groups C and E1 and groups C and E2 in their coherence rules scores. On the other hand, there is a meaningful difference between groups E1 and E2. Group E1 is more successful than Group E2. This shows the positive effect of text structure knowledge in summary writing process.

As summary writing scores which include rules of summarizing and coherence are evaluated together, meaningful difference between both Group C and Group E1 and Group C and Group E2 is observed. However, no difference between groups E1 and E2 can be recognized.

Findings of the study put forward the positive effect of the teaching program in both proficiency groups. When the achievement level of the less proficient students is evaluated, Group E1, who were given both summarizing and text structure education, were more successful than the other groups. Nevertheless, among proficient students Group E1 was only superior in applying coherence rules, where Group E1 and Group E2 had equal achievement levels in applying summarizing rules and writing summaries.

When we make an evaluation comparing less proficient and proficient groups separately we can reach these conclusions:

- Among less proficient students, there is a meaningful difference between Group C who was given traditional education and Group E1 who was given both summarizing and text structure education. Group E1 was more successful than Group C.
- Among less proficient students, there is not a meaningful difference between Group C who was given traditional education and Group E2 who was given summarizing education. These two groups share common achievement levels.
- Among less proficient students, there is a meaningful difference between Group E1 who was given both summarizing and text structure education and Group E2 who was given only summarizing education. Group E1 who was given an integrated education with text structure was more successful than Group E2.

According to these results, it is possible to assert that among the groups whose summarizing abilities were determined as less adequate by pre-test, the group which was given both summarizing and text structure education made better progress in summarizing skills.

- Among proficient students, there is a meaningful difference between Group C who was given traditional education, and Group E1 who was given both summarizing and text structure education. Group E1 was more successful in producing summaries than Group C.
- Among proficient students, there is a meaningful difference between Group C who was given traditional education and Group E2 who was given summarizing education in producing summaries. Group E2 was more successful than Group C in summarizing.
- Among proficient students there was no meaningful difference between Group E1, who was given both summarizing and text structure education and Group E2 who was given summarizing education. Although Group E1 was slightly more successful than Group E2, there wasn't a statistically meaningful difference between these groups.

These results which show the difference between the proficient students indicate a progress in the experimental groups after the pre-test. At the end of the teaching program, Group E1 and Group E2 were more successful than Group C. Moreover, no statistical difference between Group E1 and Group E2 was identified.

Consequently, when students are presented a summarizing teaching program, their summarizing skills improve. Two important consequences arrived from this study are: the proficiency level of the students and the nature of the process presented are effective variables on students' summarizing skills. One indicator of this situation is the limited success of the less proficient group. Besides, the group which was presented both summarizing and text structure skills was much more successful.

These results prove the necessity of presenting properties about text structure while teaching summarizing skills.

4. Conclusion

Summarizing is a process which requires both comprehending a text and transferring it to writing. This process includes reaching the macro structure of a text and generating textually consistent superordinate main ideas and subordinate details.

In this study, the effect of giving summarizing education, and giving expository text (problem solving) education in addition to summarizing education against giving no summarizing education is comparatively tested. The results of the study indicate that the study groups made progress by the help of teaching process. The knowledge of the proficient learners on general text structure was more advanced whereas the less proficient learners usually focused on redundancies and less important details instead of accepting the text as a whole. This result supports, Englert, Stewart & Hiebert's (1988) finding where they put forward that more proficient writers seemed to possess a more generalized knowledge of text structure by applying at both the superordinate and subordinate levels, whereas less proficient writers seemed to perform best in writing subordinate details. They also point out that most students remained insensitive to text structure in composition. So, presenting an educational process which supports text structure, comes forward as a requirement in improving summarizing skills. Within this point of view, the importance and pedagogical effect of this study becomes prominent.

Many studies in literature, (Winograd, 1984; Bean & Steenwyk, 1984; Rinehard, 1986; Nelson & Smith, 1992) point out that summary skills strategies have positive effects on comprehending texts on both poor readers and students with learning disabilities. In addition to this, in his study Friend (2001) puts forward the importance of summarizing skills for the ability of structuring a thesis statement. When less-proficient students in our study are observed, their problem appears to be comprehending the text. So, the heart of the problem lies in their disability in comprehending the macro structure in source text. This disability results in their failure in writing the thesis statement of the source text in their summaries. Thus, the need for improving the students' reading skills appears. This result creates a need to focus on reading skills.

Another interesting deduction of our study is the inefficiency of the summarizing program applied to less proficient students. The integrated program was effective on both groups. It is possible to assert that, proficient students take advantage of both teaching programs (summarizing and integrated program) whereas proficient students take advantage of merely the integrated program. This result shows the positive effect of clues on text structure and a visual chart on both proficiency groups. It also shows that presenting the schematic structure of a text, contributes to producing a coherent text. It is possible to assert that, more proficient students were able to benefit from the program presented and apply what they learned to summarizing process. However, less proficient students were less successful in applying these principles.

Consequently, informing students on how to reach the macro structure of a text by giving clues about cognitive operations such as deletion, generalizing and construction has an important effect on teaching summarizing strategies (Friend, 2001; Hare & Borchart, 1984). The results of this study show that presenting characteristics of expository text structure such as problem-solving structure, schematic structure of problem-solving, integrated with the given cognitive operations has a positive effect on improving summarizing skills. Through this approach, this study supports the studies in the literature and proposes another alternative to the activities about summarizing strategies.

This study applied in Turkish language with Turkish students, bases on skills on producing written text process, summarizing process and expository text structure. It shows the positive effect of integration of the aforementioned skills on summarizing strategies on 6^{th} grade students. It is possible to apply similar studies to different age groups on different levels in different languages.

Linguistics data serve as basis to this study. This study shows the positive effect of the use of textlinguistics on teaching summarizing skills. We think linguistics data in teaching environment aids proficient learning.

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APPENDIX 1: SUMMARY TEXT RUBRIC

SUMMARIZING RULES	**None**	**Inadequate**	**Acceptable**	**Adequate**
	0	**1**	**2**	**3**
Summary text includes a reconstructed title. (Özet metin yeniden yapılandırılmış bir başlık içermektedir.)				
Summary text includes the thesis statement of the source text. (Özet metin kaynak metnin ana düşüncesini içermektedir.)				
Summary text includes supporting idea(s) of the source text. (Özet metin kaynak metnin yardımcı düşüncesini/lerini içermektedir.)				
Summary text is the reconstructed form of the source text by original sentences. (Özet metin kaynak metnin özgün tümcelerle yeniden yapılandırılmış biçimidir.)				
All necessary information in the source text is chosen and placed in summary text. (Kaynak metindeki tüm önemli bilgiler seçilerek özet metine yerleştirilmiştir.)				
There is no trivia and redundancy in the summary. (Özet metinde gereksiz ve önemsiz bilgiler yer almamaktadır.)				
Summary is satisfying/long enough to represent the source text. (Özet metin içeriksel olarak kaynak metni temsil edecek yeterlilikte/uzunluktadır.)				
TOTAL				
COHERENCE RULES	**None**	**Inadequate**	**Acceptable**	**Adequate**
	0	**1**	**2**	**3**
Title and summary is coherent. (Başlık ile özet metin bağdaşmaktadır.)				
There is continuity between successive sentences. (Ardıl tümceler arası konu sürekliliği var.)				
Summary bases on a thesis statement. (Özet metin bir ana düşünce çerçevesinde oluşturulmuş.)				
There is subject completeness/unity in summary. (Özet metinde konu bütünlüğü/birliği sağlanmış.)				
Summary is composed on the schematic structure of the source text within a logical sequence. (Özet metin kaynak metnin şematik yapısı çerçevesinde mantıksal bir sıradüzen içerisinde oluşturulmuş.)				
TOTAL				
OVERALL TOTAL				

APPENDIX 2: SUMMARY TEACHING PROGRAM

General Principals

1. To give information about the field by the teacher
2. To apply student-centered education in order to make the students achieve procedural knowledge,
3. To apply a cooperative teaching environment in order to make students achieve procedural knowledge, meet more teaching materials and discuss their practices (in pairs),
4. To give tasks in order to reinforce informative and procedural knowledge,
5. To generate a revising and feedback system to teach informative knowledge and apply procedural knowledge correctly,
6. Not to skip to the next step before teaching informative and procedural knowledge exactly.

Lesson 1: 20 Minutes

Subject: Summarizing skill
Instructions:

- Inform the Students (Ss) on the importance of summarizing skills
- Inform the Ss on the existence of some rules of summarizing
- Tell the Ss that summarizing skills can be learned
- Tell the importance of comprehending the source text to write a summary
- Apply the activities below concerning the general principals.

Goal/Behavior: To make students achieve general informative knowledge on summarizing skills. To make them

- Achieve informative knowledge on the definition of summarizing
- Comprehend the cognitive operations applied while summarizing
  Comprehend deletion procedure
  Comprehend generalizing procedure
  Comprehend construction procedure
- Comprehend characteristics of a written summary
  Realize the need for a title
  Realize the need for a thesis statement
  Realize the need for deleting unnecessary information and redundancies
  Realize the need for important ideas in the source text
  Realize the need for constructing original sentences in summaries
  No information other than given in the source text should be given
  Realize the necessity of coherence

Activities

The teacher informs the students about summarizing skills and characteristics of a summary text by direct method.

Lesson 2: 80 Minutes

Subject: Deletion
Instructions:

- Review the previous subjects
- Tell one of the rules of summarizing is deleting unnecessary information or redundancies in the text,
- Explain deletion,
- Make Ss remember that the text should be comprehended correctly in order to delete redundancies,
- Group Ss in pairs,
- Deliver the paragraph texts prepared for each group,
- Deliver the source text and its summary
- Apply the activities below concerning the general principals.

Material: Paragraph texts relevant to level, a source text relevant to level and its summary.
Goal/Behavior:

- To make students comprehend deleting procedural knowledge as a requirement for summarizing skill. To make them
  Gain the ability to delete redundancies in the text
  Gain the ability to delete repeated information in the text
  Gain the ability to delete similar information in the text
  Gain the ability to choose relevant sentences for a thesis statement
  Gain the ability to notice the sentences deleted from the source text when source text and summarized text are compared

Activities

1. The teacher warms-up the students by reviewing the previous lesson.
2. The teacher explains that they will talk about deletion during the lesson, and delivers teaching materials to the students.
3. First, the teacher asks the Ss to look over the paragraphs, prepared for each group. (Each sentence in these paragraphs was numbered).
4. The teacher explains what deletion is and asks Ss to read the paragraphs.
5. The teacher tells the number of each paragraph and asks whether these paragraphs can be deleted or not
6. Each pair discusses it.

7. Than one group changes the paragraph text with the other group and tries to find out teacher's answer.
8. Pairs make groups of four and think about two paragraphs.
9. During this process, teacher asks Ss' decisions and tells the correct procedure.
10. The teacher delivers a source text and its summary for the next activity.
11. The teacher asks the Ss to read the source text and the summary.
12. Teacher asks the Ss to find out deleted sentences.
13. Teacher tries to create awareness by showing the deleted sentences to the class

Lesson 3: 80 Minutes

Subject: Generalizing/construction
Instructions:

- Review the previous subjects
- Tell that one rule of summarizing is to combine some of the sentences in the text and transform them to a single sentence
- Tell Ss generalizing/construction process
- Tell Ss that the text should be comprehended in a correct way in order to generalize/construct a text
- Group the students in pairs
- Deliver the paragraph text prepared for each group
- Deliver the source text and its summary prepared for whole class
- Apply the activities below concerning the general principals.

Material: Expository paragraph texts, source text and its summary
Goal/Behavior:

- To make Ss gain the procedural knowledge of generalizing/construction. To make them
  Gain the ability to transform the sample sentence groups to a single sentence
  Gain the ability to transform some of the sentences in the text to a single sentence
  Gain the ability to notice the sentences transformed from the source text by generalizing/constructing

Activities

1. The teacher warms-up the students by reviewing the previous lesson.
2. The teacher explains that they will talk about generalizing/construction process during the lesson and delivers the materials to the Ss
3. First, the teacher asks Ss to look over the paragraphs, prepared for each group. (Each sentence in these paragraphs was numbered).
4. Teacher explains the generalizing/construction procedure and asks Ss to read the paragraphs.

5. Teacher tells the number of some sentences and asks whether these sentences can be transformed by generalizing/construction or not.
6. Each pair discusses on it.
7. One pair changes the paragraph text with the other and tries to find out the answer to teacher's question.
8. Pairs make groups of four and think about two paragraphs.
9. Teacher monitors the groups and explains the correct procedure .
10. Teacher delivers a source text and its summary for the next activity,
11. Teacher asks Ss to read the source text and the summary.
12. During this process, teacher asks Ss to find out generalized/constructed sentences.
13. Teacher tries to create awareness by showing the generalized/constructed sentences to the class

Lesson 4: 80 Minutes

Subject: Thesis statement and supporting ideas
Instructions:

- Review the previous subjects
- Tell that finding the thesis statement and supporting ideas in a text, is one of the rules of summarizing
- Explain what thesis statement is
- Explain what a supporting idea is
- Explain that in order to find the thesis statement one should comprehend the text correctly
- Explain the subject and the activities that will be used during the lesson
- Group Ss in pairs
- Deliver paragraph texts prepared for each group
- Apply activities below concerning the general principals.

Material: Expository paragraph texts, source text and its summary
Goal/Behavior :

- Make Ss gain the ability to find the procedural knowledge of finding the thesis statement. To make them
  Comprehend the properties of the thesis statement and supporting ideas
  Gain the ability to choose the thesis statement and supporting ideas in the sample text
  Gain the ability to find out the topic sentence in the sample text
  Gain the ability to create a topic sentence from the sample source text

Activities

1. The teacher warms-up the students by reviewing the previous lesson.

2. The teacher explains that they will talk about identifying the thesis statement and the supporting ideas during the lesson, and delivers the materials to the Ss
3. First, the teacher asks the Ss to look over the paragraphs, prepared for each group. (Each sentence in these paragraphs was numbered).
4. The teacher explains what the procedure is for finding thesis statement and supporting ideas. Then, asks Ss to read the paragraphs.
5. Teacher tells the number of some sentences and asks whether these sentences are thesis statement or supporting ideas.
6. Each pair discusses on them.
7. One pair changes the paragraph text with the other and tries to find out the answer to teacher's question.
8. For the paragraphs where the thesis statement is not stated apparently, the teacher asks Ss to create a thesis by recognizing generalizing/construction process.
9. Pairs make groups of four and think about two paragraphs.
10. Teacher monitors the groups and explains the correct procedure.
11. For the next activity, teacher delivers a source text and its summary.
12. Teacher asks the Ss to read and compare the source text and the summary.
13. During this, teacher asks Ss to find out whether the thesis statement and the supporting ideas of the text were placed in the text.
14. Teacher tries to create awareness by showing how the thesis statement and the supporting ideas were placed into the summary to the class

Lesson 5: 80 Minutes

Subject: Producing a summary
Instructions:

- Review summarizing rules
- Deliver the source text
- Make Ss remind the procedure for producing a summary

Material: A source text relevant to the level of the Ss
Goal/Behavior: Make Ss gain the ability to produce a summary relevant to summarizing principles. To make them

Gain the ability to write a title
Gain the ability to write the thesis statement
Gain the ability to write the supporting idea(s)
Gain the ability to construct
Gain the ability to select the important ideas
Gain the ability to delete redundancies or unimportant ideas
Gain the ability not to add information not given in the source text
Gain the ability to write a coherent summary
Gain the ability to put their ideas into words

Gain the ability to review the summary

Activites
The teacher makes the Ss produce a summary by applying what they have learned

Appendix 3: Program for Teaching Summarizing Skills

Integrated with Text Structure

First four lessons are applied considering direct teaching method. Summary producing process is applied as follows.

Lesson 5: 120 Minutes

Subject: Producing a summary integrated with text structure
Instructions:

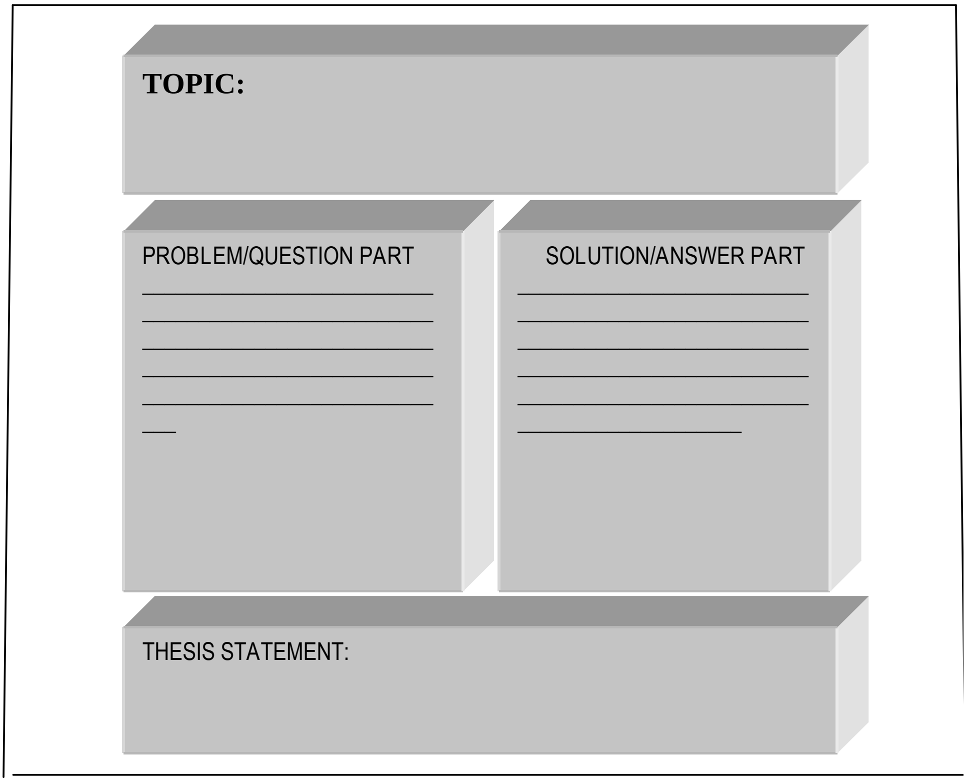
- Tell the Ss problem/solving structure
- Explain the schematic structure of problem solving (see App. 4)
- Remind summarizing rules
- Deliver the source text
- Ask Ss to fill in the text structure table in order to write a summary

Material: Two paragraph texts in problem/solving structure, one source text in problem/solving structure relevant to the level
Goal/Behavior: Make the Ss gain the ability to produce a summary relevant to summarizing principles. To make them

Gain problem/solving structure
Recognize the chart of problem/solving structure
Gain the ability to fill in the relevant places in problem/solving structure applying to the summarizing rules
Gain the ability to transform the expressions in problem/solving structure chart to a summary

Activities
The teacher makes the Ss produce a summary according to the given instructions

APPENDIX 4: PROBLEM SOLVING STRUCTURE CHART



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Chapter 10

STORY APPROACH TO INTEGRATED LEARNING (SAIL): A POSTMODERNISM CURRICULUM FOR HONG KONG KINDERGARTENS

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ABSTRACT

Changing times and postmodern perspectives have changed the traditional beliefs about child development knowledge, early childhood learning and curriculum and their relationships. Despite ongoing exchanges about how best to respond to the critique of the developmental knowledge base, few descriptions of how particular educators have reconceptualized their curriculum exist. Employing postmodern views of knowledge, learning, and curriculum, this chapter describes a new narrative curriculum developed by the authors to enact a postmodern early years learning in a typical Chinese context: Story Approach to Integrated Learning (SAIL). It first reflects on the existing early childhood curricula in Hong Kong and the associated problems and challenges. Second, it reviews the literature about the reconceptualization of early years learning and curriculum to seek possible solutions to Hong Kong problems. Third, a brief introduction of SAIL is presented and an example is given to illustrate how SAIL can put postmodernism curriculum into practice. Last, this chapter concludes with a discussion of some of the challenges and future directions relating to the shift from developmental to postmodern practices in the development of early childhood curriculum.

INTRODUCTION

In the past 20 years, the National Association for the Education of Young Children (NAEYC) has been advocating the concept of developmentally appropriate practice (DAP), which has now been widely accepted and supported by early childhood educators all over the world. This framework, however, has been challenged by many scholars for being ethnocentric and ignoring the range of life contexts and knowledge experienced by children from diverse cultural, ethnic, linguistic and value contexts (Canella, Swadener & Che, 2007; Kessler & Swadener, 1992). These concerns have been addressed using different methods and forms of critique, including qualitative research that attends to the voices of people who are often under-represented. The Chinese children and their learning in the early years, for example, are rarely studied from the perspective of postmodernism. Inevitably, the multicultural worlds of childhood in postmodern Chinese societies present great challenges as well as opportunities for the development of early childhood curriculum. This chapter analyzes why and how a new narrative curriculum was developed by the authors to enact a postmodern early years learning in a typical Chinese context: Story Approach to Integrated Learning (SAIL) for Hong Kong children.

I. Early Childhood Curricula in Hong Kong: Problems and Challenges

Early childhood education (ECE) is not compulsory in Hong Kong, but almost all children aged between 3 and 6 years (98%) are currently enrolled in kindergartens (Hong Kong Council of Early Childhood Education and Services, 2006). Kindergartens in Hong Kong are stand-alone early childhood programs that enroll children of three age-groups (ages 3-4, 4-5, and 5-6). Thus, kindergartens mentioned in this chapter are different from those one-year programs located in elementary schools in the United States. Kindergartens in Hong Kong are all owned by non-governmental organizations, private enterprises, or individuals (Li, Wong, & Wang, 2008). Most of them (80%) are non-profit-making kindergartens that cannot make more than 5% profit per year (according to governmental audit). The remaining 20% are private, independent kindergartens that could make less than 10% profit (otherwise they will be asked to reduce tuition fee), which school owners are allowed to pocket. Those private independent kindergartens have no obligation to report their financial details to the government, as they do not receive any public subsidy. Whether profit-making or not, kindergartens in Hong Kong have been plagued with high tuitions, low financial transparency, and poor quality (Li & Rao, 2005; Li et al., 2008).

The aim of pre-primary education in Hong Kong is to provide children with a relaxing and pleasurable learning environment to promote a balanced development of different domains. The *Guide to the Pre-primary Curriculum* (Curriculum Development Council, 2006) was issued by the education authorities to promote a balanced curriculum, child-centred learning and DAP, early reading and emergent literacy, early bilingualism, home-school partnership, smooth transition to school, and integrated curriculum. Four developmental objectives are suggested in the curriculum framework: physical development, cognitive and language development, affective and social development and aesthetic development. These objectives are thought to be achieved through six learning areas: physical fitness and health, language, early mathematics, science and technology, self and society and arts.

The foremost problem of ECE in Hong Kong is the quality of education itself. Educational authorities claimed that 80% of the profit and 35% of the nonprofit kindergartens failed to achieve the minimum quality standard (*Tai Kung Pao*, 2006). Since the 1990s, educational reform has been conducted in the field to promote a constructive curriculum, child-centered pedagogy, DAP, progressive education, and professional development of early childhood teachers (Rao & Li, 2009; Wong & Rao, 2004). Even so, limited funding has made Hong Kong kindergartens incapable of recruiting and retaining high quality staff (Li & Rao, 2005). Until 2005, only 23.8% of kindergarten teachers had diploma-level qualifications, and only 12.8% of principals received a degree (Hong Kong Professional Teacher's Union, 2006). Accordingly, these under-qualified practitioners were not able to incorporate the DAP and progressive education ideas advocated by the education authorities into their practice and relied, instead, on traditional and inappropriate teaching methods that fostered compliant children rather than enthusiastic learners (Li & Rao, 2005).

Li and Chau (2009) analyzed the quality review ports on 155 kindergartens issued by the education authorities in order to summarize the major problems in Hong Kong early childhood education. This analysis focused on three main domains of the *Performance Indicators* issued by the eudcation authorities: "Management and organization", "Learning and teaching", and "Support to children and school culture". It was found that the critical problems lie in the three domains: lack of self-evaluation mechanism, inappropriateness of curriculum and child-evaluation, and weak school-home collaboration, respectively. In addition, four common problems were found in Hong Kong early childhood curricular: passive involvement in a chaotic reform, overloaded and unbalanced curriculum, nonsystematic and nonstructural curriculum design, lazy-faire and bush-fighting curriculum policy (Li & Chau, 2009). With such a large number of problems, it is high time for educators in Hong Kong to rethink the true meaning of learning in the early years.

II. Reconceptualization of Learning in the Early Years

Learning is the central to all the early childhood education matters. Understanding how learning occurrs and develops in the early years has been the mission of developmental and educational psychologists for decades. Although there are many different theories and approaches to understanding the phenomonen of learning, most of them could be classified into three main categories: behaviorism, cognitivism, social construction of knowledeg, and postmodernism.

Behaviorism. Behaviorists believe that the association between any particular stimulus and response can be reinforced by reward or weakened by punishment. This is essentially the concept of operant conditioning, a principle which was developed by Skinner (1969). Underlying this approach is the belief that learning is governed by some invariable principles, which are independent of the learner's conscious control. In sum, behaviorism originates from a strongly objectivist epistemological position, and reference to unobservable states, such as feelings, attitudes, and consciousness, are often rejected. Under this position, human behaviour is regarded as something predictable and controllable. Skinner's theory led to the development of teaching machines, computer-assisted instruction, and multiple choice tests. Behaviorism denies and ignores mental activity as the basis for learning. In this view, learning is determined by external environmental structures that lead to reinforcement of behavior, rather than by the learner's mental processes or conscious thought. Nowadays there has been a strong movement away from behaviorist approaches to teaching in the early years, but its influence is still strong in some Chinese classrooms.

Cognitivism. Cognitivists focus on mental processes, and insist that these internal and conscious representations of the world are essential for human learning. They therefore stress not only on the environment, but also on the way in which the individual interprets and makes sense of the environment. Individual is no longer the mechanical product of his environment, but an active agent in the learning process deliberately processing and categorizing the stream of information fed into him by the external world (Fontana, 1981). Thus, the search for rules, principles or relationships in processing new information, and the search for meaning and consistency in reconciling new information with previous knowledge, are key concepts in cognitive psychology. Practically, teachers who place a strong emphasis on learners' ability to develop personal meaning through reflection, analysis, and construction of knowledge through conscious mental processing would indicate much more of a constructivist epistemological position (Bates & Poole, 2003).

***Social Construction of knowledge*:** The abovementioned theories present a kind of deterministic view on human learning, in which behavior and learning are believed to be rule-based and operate under predictable and constant conditions where the individual learner has little control. The importance of consciousness, free will, and social influences on learning has been neglected. As suggested by Rogers (1969), every individual exists in a continually changing world of experience in which he is the center, and the external world is interpreted within the context of their private world. Therefore, reality is always tentative and dynamic to individuals, who are consciously striving for meaning to make sense of their environment in terms of their past experience and present state. Under this perspective, each individual is considered unique because each person has an idiosyncratic way of attributing events and linking up old and new experiences (Bates & Poole, 2003).

***Postmodernism*:** Under the postmodernism view, knowledge is: (1) tentative, fragmented, multifaceted and not necessarily rational; (2) socially constructed and takes form in the eyes of the knower; (3) contextual rather than "out there" waiting to be discovered; (4) and hence can shift as quickly as the context shifts, the perspective of the learner shifts, or as events overtake us (Kilgore, 2001). Knowledge is contextualized thus individuals can hold two completely incongruent views of one subject at the same time. The postmodern approach to learning is founded upon the assumption that there is not one kind of learner, not one particular goal for learning, not one way in which learning takes place, nor one particular environment where learning occurs (Kilgore, 2001). Another important feature of postmodernism is its emphasis on diversity of the world and its objection to core values of modernism on unity and universality. Postmodernism welcomes uncertainties, complexities, subjectivities, and diversities, because there are multiple realities, multiple perspectives, and multiple learners in the world. Accordingly, Li (2007) summarized postmodernism perspectives on early childhood learning as follows: (1) Children pay close attention to the immediate reality wholeheartedly; (2) Children exert their effort to make sense of the world; (3) Children create theories by filling in the blanks in their understanding of the world; (4) Children's learning varies and depends on contexts; (5) Children learn about the world via personal stories and narrative enquires; (6) Children prioritize the wholeness of everything; (7) Children believe in the magic power of words, which are the fountain of early thinking.

In Hong Kong, there are different approaches to early childhood teaching and learning, for instance, Project Approach, High Scope and Reggio Emilia, and each of them are based on different theoretical orientations. However, since many of these approaches are based on Western educational researches, their applicability to the context of Hong Kong kindergartens is questionable. Li (2008) analyzed the feasibilities of implementing the mainstream curriculum models in Hong Kong kindergartens, achieving a conclusion that Project Approach, High Scope and Reggio Emilia are not implementable whereas narrative curriculum is culturally appropriate.

Apart from the difficulties in implementing Western approaches in Chinese context, Hong Kong kindergartens are facing challenges posted by the highly pluralistic and diversified postmodern world which is characterized by an influx of knowledge and multiple realities.

In order to meet the new challenges, it is vital for kindergartens in Hong Kong to adopt a culturally, contextually and child-individually appropriate practice (3CAPs) (Li, 2007) in teaching and learning. Reflection on the curriculum theories indicates that the postmodernism autobiography theory and Story Approach might be the best model for Hong Kong kindergartens to develop integrated curricular (Li, 2008). Story could be both cognitive and affective means to deliver the knowledge, which is easy to remember and capable to expand into an integrated curriculum. To implement story approach in Hong Kong kindergartens, Li developed and published the learning package of SAIL (Story Approach to Integrated Learning) with Oxford University Press in 2003, and the second version (SAIL2.0) in 2007.

III. SAIL: Story Approach to Integrated Learning

What is SAIL: SAIL is a transdiscplinary teaching approach using stories as the framework to construct an integrated curriculum, and to bring out themes and learning activities. And the second version of SAIL was revised to embrace the diversity and freedom of children, which are the core values of postmodernism. Apart from incorporating new theories, the SAIL2.0 package also followed the *Guide to the Pre-primary Curriculum* (Curriculum Development Council, 2006) by emphasizing the importance of life education in order to foster children’s interest in scientific and aesthetic areas. Teachers can use stories as a platform to develop a series of activities, for instance, art, creation of new stories and drama performance, so as to enhance teacher-children interaction and support children’s engagement and decision making in their own learning. With these amendments, SAIL2.0 becomes an effective tool to smoothen children’s transition to primary school by embracing the importance of reading, and to enhance children’s language development with emergent literacy and whole language approach (Li, 2007).

Learning with SAIL is a journey of story and exploration, which aims at developing children’s multiple intelligences through hand-on experience and active exploration of materials through multiple senses and human interaction. With SAIL, teachers are able to follow the storylines and develop explorative learning activities to enhance children’s language, mathematics, interpersonal, intrapersonal, music, art and spatial intelligences. The stories in SAIL provide children with a complete learning context so that their life experience can be easily linked to the learning activities, and these activities thus become more meaningful to them. To assess children's development in different areas, teachers are suggested to use learning portfolio to document daily teaching and learning activities.

Traditional integrated curriculum usually has clear themes, but does not have a clear clue or framework to support children's construction of knowledge. SAIL is different from the existing curriculum in the sense that it uses interesting stories as the framework to link the content and learning activities of different domains. With a complete and meaningful integrated curriculum, children can construct their own knowledge in a more effective way. In short, SAIL has the following advantages: (1) children love stories thus learning through listening a story will be very happy and enjoyable; (2) teachers love stories because storytelling skills are much easier to acquire than those singing and dancing skills, teaching through storytelling is also enjoyable and especially doable to Hong Kong kindergarten teachers; (3) multiple learning activies could be incorporated into well-designed stories thus the curriculum could be very comprehensive and inclusive; (4) well-writen stories could provide children with interesting learning context and even build up a meaningful ecology for the thematic learning; (5) the open framework provided by stories could provide teachers with an ideal platform to scaffold young children's learning, and teachers could easily adjust the pace of teaching according to children's interest and development; (6) stories are perfect materials for emergent literacy and whole language learning activities.

How to do SAIL: SAIL can be done in four steps: story telling, theme exploration, extension activities and portfolio assessment.

Step 1: Story telling. Before telling stories to the class, teachers should mentally rehearse the content and scenario of the stories so that they become ready for their storytelling performance. When telling stories, teachers should pay attention to their eye contact, gesture and intonation. More importantly, teachers should link the new story with children's past experience so that the story becomes more meaningful to them.

In addition, children can also tell stories. When being asked to tell stories, children may feel worried, excited or shy. However as teachers, it is important to encourage children by: (i) providing a suitable theme which is based on children's life experience; (ii) allowing children to think and organize their mind before telling the story; (iii) dividing children into groups so that they can be inspired by listening to others, and can rehearse the story among their peers before telling to the class; and (iv) playing music which is related to the story so as to aid children's imagination.

After storytelling, it is vital to have feedback immediately so as to consolidate children's understanding towards the story. Different post-story activities such as direct repetition of story, question-and-answer session, counting the number of characters, role play, creation of artwork and peers interview, are good ways to help children remember the story. During feedback sessions, teachers should guide children's attention to the main points of the story through proper questioning skills, for example, by asking "when", "where", "who", "what", "why" and "how" (the "5W1H" questions), so that children can analyze and conclude the story in a more systematic way.

Step 2: Theme exploration. As a series of integrated activities, theme exploration aims at deepening and widening children's understanding towards different subject matters developed from the story. To achieve this goal, teachers may develop the story theme webs with children. Story theme web is basically a kind of visual thinking frame which helps children to find out the links between different subjects and themes in a story, and to provide children with a starting point for their project, investigation or creation of new stories.

Daily news sharing is another way to aid children's exploration of a story theme. Children love news sharing and are highly engaged in this kind of activity (Li, 2007). News sharing could link the story with children's daily experience and encourage them to pay more attention to what happen around them everyday. They can also gain a more concrete picture of how to apply what they learnt in a story to real life. Music, physical and art activities are the necessary tools to support a story because all these activities provide children with a meaningful and complete scenario for learning. A good scenario provides children with room for imagination. For example, after telling children a story about animals, teachers may play a song with different animals as characters during music period. With the aid of appropriate musical instruments, children can start imagining themselves as the animal characters and acting out the stories accordinlgy.

After children have familiarized themselves with the original story, teachers can guide them to develop or write a new story. Although using the same story as the prototype, young children could create different new stories as they have different family background, life experience, ability and interest. Children are encouraged to develop their new stories in the following ways: (i) rewriting the beginning of the story by creating a biography for the characters; (ii) rewriting the ending of the story by creating an ideal ending for the characters; (iii) creating songs or poems based on the content of the original story, and so on.

Drama, an alternative way of storytelling, could also be used to explore the theme. Drama performance provides children with room to imagine, explore, perform, communicate and express their opinions and feelings towards a story. During drama performance, children are engaged in the learning activity physically, emotionally, intuitively and intellectually. By role-playing different characters, children have a chance to feel what others feel, and this helps them to develop their perspective-taking and introspective ability.

Step 3: Extension activities. After developing various activities around the story theme, children might have found one or two interesting areas. To further understand the particular phenomenon or concept, children might need to do some projects. Doing project in Hong Kong kindergartens is different from the project approach advocated by Katz and Chard (2000), as the choice of theme and progress of investigation are monitored and guided by teachers. With teacher's guidance, children can choose a topic which interests them the most for investigation. Through solving authentic problems with project works, children become the principal investigators who are responsible for their own learning and living, and the new knowledge they build up in the project will have more personal meaning and longer retension than those they learn from listening.

The project investigation could be done in three steps: (i) children find out the interesting areas for further investigation from the story; (ii) children collect evidence by doing observations or experiments, or by searching different sources such as internet, books, photos, news and interviews; (iii) children consolidate and present their findings through various medias such as, short written report, drawings, PowerPoint and story telling, etc.

Teachers could act as the observer, supporter, co-operator, guide and helper when childre do the porject investigation. To achieve these aims, teachers should acknowledge the importance of hand-on experience and direct manipulation in the investigation process and limit their intervention as far as possible. When children get stuck in any critical points, their interest towards the theme may dramatically reduce, or they may immediately ask teachers for a correct answer for the problem. At this moment, rather than directly provide children with answers, teachers should scaffold children's learning by guiding them to observe their peers, or helping them link their past experience and learnt knowledge with the new problem.

Step 4: Portfolio Assessment. Assessment plays an important role in early childhood education because it allows teachers and parents to understand children's development in different aspects. Assessment also provides information to teachers for adjusting their teaching style and curriculum to fit the learning style of the children.

In the past, parents in Hong Kong placed high value on traditional assessment methods, for instance, dictation, copying and paper-and-pencil tests. However, rather than helping teachers and parents to understand children as a whole person, these methods can only test children's factual knowledge by rote memorization. To assess children's learning in all developmental aspects, learning portfolio would be a more appropriate choice. After observing children's daily activities and collecting their work, teachers should systematically store and analyze these data so that portfolio becomes the evidence of children's learning and indicator of their teaching effectiveness.

In sum, an appropriate assessment should be a continual and dynamic process which is to be done in various phases. It is suggested that teachers should use various methods in collecting data, and should engage children in the assessment process. Children's personal diary, week journal, peer and self evaluation should also be collected to establish a triangulation to validate the results obtained from teacher observation. With such a triangulation of assessment sources/methods, it is possible for teachers to obtain a complete picture of children's development in different areas.

An example of SAIL: The appendix is a five-day teaching plan which shows how SAIL was actually carried out in a local Hong Kong kindergarten. The theme was "food", and all the learning activities were developed based on one of the SAIL stories *"Princess's birthday party"* (Li, 2007). Other teaching materials including the supplementary stories, videos, food and money were used to help children link the story with their life experience.

As shown in the appendix, the learning activities naturally covered the three key elements ("knowledge", "skill" and "attitude") and six learning areas suggested by the *Guide to the Pre-primary Curriculum* (Curriculum Development Counhcil, 2006). And a balance of the six learning areas was proposed in the teaching plan. Mathematic and scientific explorations could be done in whole class and group/ free choice activities period. Emergent literacies could be facilitated through group discussion and presentation. Music, art and physical education could also be delivered to the children.

All the learning activities were stemmed from the core story, and were interlinked tightly with each other, forming a complete and meaningful learning context for children. For instance, before conducting a field study in a supermarket, all the common food that could be found in local supermarket were first introduced to the children through the core story, and then the concept of money and its usage were introduced for later application in the visit.

These activities also showed how maths could be closely linked with stories as well as children's daily experience. Apart from the whole class activities and group/free choice activities, music and physical activities were also the necessary piece to complete the whole puzzle of learning with SAIL. After learning the song *Min-nong* (*Pity on Farmers*), teachers made use of the lyrics and pictures in the story book to carry out life education, asking children to treasure food and appreciate farmers' hard work.

The four steps of doing SAIL were shown in the lesson plan, except for the step of portfolio assessment. Teachers started each school day with storytelling and immediate feedback. Although there was no explicit news sharing in the teaching plan, teachers did deliberately link current issues with the story and other learning activities, such as, the ways of preventing birds' flu and the concept of "bring your own bag". As the extension activity, a visit to supermarket was conducted. Although a field study is not a complete project, its nature is a kind of project investigation which contains the process of "plan, do and review": Before going to supermarket, children had to plan what they are going to buy with the limited money; Then, children had to immediately check the feasibility of their plan in the supermarket and even had to change their shopping plan accordingly. In this case, children actively applied what they learnt about money to solve their real problems. Finally, after children presented their difficulties to the class, teachers sorted out the common difficulties and systematically consolidated and analyzed children's presentations. As children could test their hypothesis through trial-and-error and reach to their own conclusions with teachers' guidance, this activity enhanced children's problem solving ability.

The core values of postmodernism were shown in various story-based learning activities. For instance, the art activities allowed children to learn the necessary skills while fostering their creativity and individuality. Open-ended questions were used to guide group discussion and presentation so that children were encouraged to use their imagination to think of any possible outcomes. Different answers and various outcomes were really welcome by the teachers with respect for diversity in child development. The extension activities "healthy menu" and supermarket visit broke the boundary between home, school and community. The enhanced collaboration and increased understanding between different parties could in turn facilitate young children's daily and life-long learning.

IV. School-Based Curriculum: DAP, 3CAPS and Beyond

Four approaches to developing school-based curriculum were found in Hong Kong kindergartens (Li, 2006): (1) The 'textbook' approach: some kindergartens just choose one set of learning package produced by local publisher and rely entirely on it. Teachers just copy and past the learning materials to prepare their 'own' teaching plans. This is an easy-to-do approach and is really welcome by some teachers. But the learning package prepared for public use might not be suitable for a particular class and even a particular kindergarten. Their curriculum is thus far away from a school-based one. (2) The 'school-based tailoring' approach: Some kindergartens choose a learning package as the prototype and conduct school-based even class-based tailoring to develop their school-based curriculum. Normally, a task force led by prinicpal or head teacher is responsible for the school-based tailoring, and they just pick up the suitable parts from the learning package basing on their observation and judgement of children's developmental needs and interests. This is a relatively time-saving approach to developing a school-based curriculum that demands little manpower. (3) The 'piling up' approach: Some kindergartens prefer choosing two or more learning packages developed by local publishers and incorporate all of them into a kind of school-based curriculum. This approach could draw upon the merits of different learning packages, but could also produce a chaotic and messy curriculum. (4) The 'developing on their own' approach: some kindergartens choose to develop their own school-based curriculum independently, without making reference to any other learning packages. This method allows a kindergarten to develop a truly school-based curriculum which is solely based on the needs of school and its children, but it demands substantial involvement of curriculum experts as well as enormous time and human resource. Unfortunately, it was found that Hong Kong teachers were not qualified enough to develop school-based curriculum on their own, and the reality of this model has been described as ''every family produces steel in the backyard and re-invents wheels for private car''(Li, 2006). This implies that without expert guidance and other input, it might be impractical to ask kindergarten teachers to develop school-based curriculum on their own. Instead, principals, teachers and experts should work collaboratively to develop school-based curriculum.

In addition, previous studies found four major barriers on the way to developing school-based curriclum (SBC) in Chinese kindergartens: lack of curriculum experts and their guidance, short of resources for curriculum development, under-qualified teachers, and neglection of SBC by school management (Li, 2006). And the 'school-based tailoring' approach was found the best one for Hong Kong kindergartens to develop their own SBC (Li, 2006). SAIL is believed to provide an ideal platform to put this method into practice (Li, 2007). When doing SAIL, "story" becomes a thread which links various learning contents and weaves learning activities into a complete fabric. With a nest of well-established links, an interesting learning context and a meaningful learning ecology could be established naturally. The context in turn provides teachers and children with a script which allows them to make use of their creativity and imagination to conduct various learning activities accordingly. The open-ended nature of stories provides teachers with an ideal open framework, which can be adjusted, extended and changed at any time to meet the needs and interest of children. This provides huge room for school-based even class-based tailoring of the chosen curriculum. In particular, the structure of SAIL allows the three key elements and six learning areas suggested in the *Guide* to unfold naturally and gradually in different learning activities, so that children can learn in a more interesting and meaningful way.

During the past decades, DAP has gradually become the practical guide for early childhood educators all over the world. But the followers have found some insoluble problems in this framework: how to judge DAP? where does the developmental norm come from? are these norms reliable and universal? who is supposed to do the judgement? are early childhood practitioners qualified to do it? and how to facilitate children's individualized development with DAP? Obviously, the framework of DAP is very ethnocentric and ignors the range of life contexts and knowledge experienced by children from diverse cultural, ethnic, linguistic and value contexts (Canella, Swadener & Che, 2007; Kessler & Swadener, 1992). In fact, there are multipe realities of early childhood, multiple perspectives on early childhood learning, and multiple learners in the early years. Using developmental norms to unify the learning of young children under varying contexts in such a postmodernism society is absolutely an impossible mission. Rather than emphasizing on developmental appropriateness, we believe, it is more important to focus on the cultural appropriateness in curriculum planning. Furthermore, a successful postmodernism curriclum should contain 3CAPs: culturally, contextually and child-individually appropriate practice (Li, 2007). That means a good early childhood curriculum should be sensible to the individual differences among young children who live in varying cultures (societies), contexts (kindergartens) and families (children). The learning in the same classroom with the same curriculum should be individualized to meet children's varying needs. Comparing with NAEYC's DAP framework that focuses on the commonalities and universalities of learning and development in the early years, 3CAPs might be a more sensible and appropriate framework for us to develop a postmodernism curriculum.

SAIL is such an exemplar of the postmodernism curriculum with 3CAPs, because the stories not only provide open framework and flexibilities for individualized learning, but also reflect the cultural, contextual and individual differences (Li, 2007). Through school-based and even class-based tailoring, early childhood educators could present their young learners with a culturally, contextually and individually appropriate school-based curriculum. And through the co-construction of those stories by teachers and students, learning activities with SAIL could become children's personal stories, living stories, and ultimately, their autobiographies. In this connection, we agree with the claim that early childhood cuirriculum should be young children's autobiographies (Li, 2007). And the authentic curriculum delivered by SAIL would provide children with a meaningful context to foster the development of necessary abilities which allow them to survive in this ever-changing postmodern world.

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Appendix: An Exemplar of SAIL

Theme: Food

<table>
<tr><th>Date</th><th>Content of learning activities</th><th>Materials</th></tr>
<tr><td>19/11/2007 (Monday)</td><td>(A) Whole class activities
1. With the aid of PowerPoint (story book "Princess's birthday party", p. 4 – 11), introduce to children the types of food presented in the story
2. Use cloth to cover the food (*food with unique shape, kexture and odor, eg. ginger, dried mushrooms, hairy gourd, garlic, cheese, etc). Ask children to guess by touching first. Later, take away the cloth and ask children to observe the food closely. Teacher may ask children to taste some of the food (eg. cheese) if possible. Then, teacher may ask children tell us the type of these food and describe their characteristics (shape, texture, odor and color).

3. Encourage children to use sentence pattern "I like eating ______ food" to make sentences orally.

(B) Group/ free choice activities
1. Explorative game: "Hard VS Soft Bread"
(introduce the concept of "hard" and "soft")
• use big book p. 24 to tell children the process of making bread
• put a baguette into a paper bag. Ask children to touch and guess what is inside.
• put a soft butter bread into a zipper bag. Let children touch the bread and scaffold them to tell the difference between the baguette and soft butter bread.
• introduce to children the concept of hard and soft.

2. Creative game: "Tasty noodles" (Artwork: cut 15cm-long straight lines)
• cut string/ knitting wool into 15cm-long straight lines (use ruler to measure)
• decorate the plate with color and paste the string/ wool onto the plate
• use color paper or any other materials to add extra toppings on the noodles

3. Writing

4. Free choice activities: language/ science/ music/ art/ library/ family corners

(C) Music/ Physical Activities
1. Game: "Quick turn" (skill training: scoot turning while avoiding obstacles)
2. ride bicycle
3. throw bean bags

(D) Tidying up Activities
Encourage children to share with the class their own artwork and learn to appropriate other's work

(E) Extension Activities
Ask children to design a "healthy menu" with parents. Children may either take some photos or draw some pictures for the procedure of making that dish so that they are present it to classmates tomorrow easily.</td><td>PowerPoint

Different kinds of food
Cloth/ any useful materials for covering the food

Baguette
Paper bag
Soft butter bread
Zipper bag

Paper plates
Strings/ knitting wool
Glue, scissors, ruler,

Color pencils
Color paper or any other useful materials</td></tr>
</table>

Date	Content of learning activities	Materials
20/11/2007 (Tuesday)	**(A) Whole class activities** 1. Link today's lesson with yesterday's story by reminding children the types of food which was stated in the story. Pick up the type "Fruit and Vegetable" and then show children a (picture of) carrot.	A picture/ photo of carrot or a real carrot
	2. With the aid of CD-ROM, tell children the story "*Carrot's Journey*".	CD-ROM
	3. After the story, teachers may ask children the following questions: • What made carrot itchy? • Where did carrot stay in this journey? • What did carrot virtually become? Where did carrot finally go? • What should you do after going to the toilet? (Big book p.18)	"*Carrot's Journey*"
	4. Elaborate on the content of big book p. 18 – 19, tell children the relationship between food, nutrition and growth, eg. dietary fiber, which is found in fruit and vegetables, can enhance peristalsis and prevent constipation, etc.	Big book (p.18, 19)
	5. Show children the food pyramid (where should different types of food be placed in the pyramid) and remind them the importance of balanced diet.	Picture of food pyramid
	(B) Group/ free choice activities 1. Social game: "Healthy menu" • ask children to take turn and tell classmates about the "healthy menu" that they have designed with their parents. • during the presentation, encourage children to make sentence using the sentence pattern of "I love eating ____ and ____" according to the content of their menu. • form children into groups of 6 – 7. Ask them to discuss which student's menu in their group is/ are the healthiest, and then ask children to present their discussion result to us with reasons. (* encourage them to apply the knowledge that they have just learnt about the food pyramid during the discussion/ reasoning process)	Worksheet ("healthy menu") Picture of food pyramid
	2. Manipulative game: "Clipping candies" (ability to use chopsticks and add within 10) • There are 3 equations on a plate. Calculate the correct answers and use chopsticks to pick the answers (CPM number granule) out.	Plate (teaching aids), CPM number granule, chopsticks
	3. Writing	
	4. Free choice activities: language/ science/ music/ art/ library/ family corners	
	(C) Music/ Physical Activities 1. Breathing: pretend to blow off the candles 2. Teaching new song: *Min-Nong* (*Pity on Farmers*) 3. revise the signs of the following so-fa names: la, so, mi, do	

Date	Content of learning activities	Materials
21/11/2007 (Wednesday)	**(A) Whole class activities** 1. Ask children to guess what type of food (fish) the teacher is going to introduce today. Use a riddle to guide children through their process of guessing. 2. With the aid of the story "*Princess's birthday party*", point out to children the fact that most of the fish we eat nowadays are from fish pond because over-fishing in open sea greatly reduces the number of fish habitat. Since natural resources are always limited, we should treasure them. 3. Teacher may continue to say, "Now Little Princess knows the source of fish. How about meat and rice?" Use pictures from big book to illustrate these facts. 4. When talking about the sequence of rice cultivation, apart from showing children pictures, teachers may use the lyrics of *Min-nong* (*Pity On Farmers*) that they have learnt yesterday to illustrate the hard work of farmers, so as that they can build up a sense of appreciation towards farmers' hard work. 5. Show children the video clip (government advertisement) "Don't touch living poultry" to point out the ways to prevent Birds' Flu. **(B) Group/ free choice activities** 1. Creative game: "Fruit basket" (Artwork: tear and paste) • show children the pictures of fruits and basket • use color pencils to outline a fruit basket on white drawing paper • tear color paper into small pieces and stick onto the fruit basket 2. Language game: "Delicious puzzle" (sentence making and spatial concept) • finish the puzzle first, and then write the correct answer (according to what is on the puzzle) to complete the sentence. • read the sentence aloud 3. Writing 4. Free choice activities: language/ science/ music/ art/ library/ family corners **(C) Music/ Physical Activities** 1. Game: "Smart little scarecrow" (skill training: scoot turning and balance) 2. to think of methods other than "walking" to go over the floor mats 3. spin Hula-hoops	Riddle big book p. 4 -7 (pictures) pictures, lyrics Video clip White drawing paper, color paper, color pencils, glue, any other artwork materials Cardboard (teaching prop), whiteboard marker, puzzle

Date	Content of learning activities	Materials
22/11/2007 (Thursday)	**(A) Whole class activities** 1. Use the story "*Princess's birthday party*" as the framework to guide children to think of the common ways of getting food. Guide children to think of the answer "supermarket" (so as to echo with tomorrow's activity of supermarket visit).	
	2. Show children the CD-Rom of story "*Little Worm, Large Discovery*" and photos of supermarket. Ask children to observe the appearance of supermarket, the goods to be sold, the ways of classifying goods into different categories, etc.	CD-Rom, Photos of supermarket
	3. Teacher uses puppets to "role play" different behaviors in supermarket (eg. bring with our own bags, run in supermarket, put goods in wrong place, etc). Ask children to differentiate the proper behavior from improper behavior, and discuss in small groups the reason why these behaviors are considered as proper/ improper.	Puppets
	4. Teacher may ask children, "To buy food from supermarket, what do we need?", so as to introduce to children value of notes and coins in Hong Kong.	Money
	5. Let children to see a supermarket product (eg. A can of soft drink) with price tag on it. Ask children to observe and find out how much they have to pay for.	A supermarket product with price tag
	6. Use EVI story "*The story of money*" to tell children the origin and history of money. Then, imagine how our live change would if there is no money (eg. have to trade by bartering). Ask children to discuss in small groups and present to the class their thoughts.	EVI story
	(B) Group/ free choice activities 1. CPM teaching aids: "Milk series box 9 – 11" (knowledge on money) 2. Maths game: "Happy shopping" (money usage) - Put the correct coins into the boxes according to the prize stated on the cardboard 3. Writing 4. Free choice activities: language/ science/ music/ art/ library/ family corners	CPM Milk series 9 – 11 Cardboard, CPM money
	(C) Music/ Physical Activities 1. vocalization: follow the rhythm made by shaker and ask children to imitate the rustling sound of shaker 2. musical movement: move like food-in-hot-pot according to the music 3. rhythm game: quadruple time	
	(D) Tidying up Activities Remind children to bring along with them $10 and a shopping bag for the supermarket-visit activity tomorrow	

Date	Content of learning activities	Materials
23/11/2007 (Friday)	**(A) Whole class activities** *Before the visit:* 1. Divide the whole class into 3 large groups. 2. Ask children to plan in small groups about what they are going to buy in the supermarket visit. Write the items down on a shopping list. 3. Remind children the "Dos and Don'ts" (proper and improper behaviors that were discussed yesterday) in supermarket. *During the visit:* 4. Teachers walk around the supermarket together with the whole class and introduce to children the names and goods to be sold in different sections. 5. Then, children may go shopping with their group mates. There should be 1 teacher following 1 group, observing and guiding them through the process of purchasing whenever they face any difficulties. 6. Before the payment, ask children to check and see if they have enough money, and remind them to use the shopping bags that they brought. *After the visit:* 7. Ask children to remain in their groups and check with each other to see whether they have bought all the goods they planned to buy (as written in the shopping list). 8. To share their experience, difficulties and observation with their group mates, for example, the way of categorization that they have seen in supermarket, which category does the goods bought by most of the group mates belong to, etc. 9. Select a representative from each group to present to the whole class what they have discussed just now. **(B) Tidying up Activities** To conclude and sum up the comments from students about today's supermarket visit.	Paper, pencil $10, shopping bag

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Chapter 11

CURRICULUM DEVELOPMENT FOR STEM INTEGRATION: BRIDGE DESIGN ON THE WHITE EARTH RESERVATION

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ABSTRACT

To promote STEM (science, technology, engineering, and mathematics) education with American Indian students in grades 5-8, a civil engineering focused curriculum was designed through collaboration among educators, researchers, and engineers. The curriculum was created to introduce American Indian youth to career opportunities in civil engineering, various civil engineering concepts, and the role of civil engineers in the technology driven 21st century. The emphasis of the curriculum is placed on structural engineering, which is a branch of civil engineering concerned with the design and structure of buildings, bridges, and roads. The curricular activities focused on one particular structure - bridges. Through the activities the students engaged in engineering, as well as science, mathematics, and technology.

INTRODUCTION

The Education of American Indian Students

Researchers have addressed various issues regarding the education for American Indian students (e.g., Bradley, 1984; Nelson, Simonsen, & Swanson, 2003; Preston, 1991). School problems such as low enrollment and graduation rates, large percentage of absenteeism, suspension and expulsion, low achievement scores on math, science, and reading, and the high drop out rates are commonly associated with American Indian students' education (U.S. Department of Education, National Center for Education Statistics [NCES], 2008a). The rates of absenteeism, suspension, and drop out are higher in schools that serve only or a high percentage of American Indian students. This is particularly true for students who enroll in reservation schools. Tribes have made effort to improve the education in reservation schools; however, American Indians are still behind in relation to the education that the White population has in the U.S. In 2007, approximately 44% of American Indians in the U.S. completed an undergraduate or graduate program, 36% of American Indians had a high school diploma, and 20% had no high school diploma while only 9% of Whites did not finish high school (NCES, 2008a).

Most American Indian students go to the schools in rural areas. While the majority of these schools are located far away from the urban areas, others are close to the urbanized areas. American Indian students enroll in public schools, private schools, or schools that are administered by Bureau of Indian Education. Almost 90% of the American Indian students attend public schools (U.S. Department of Education, 1991). In the 2005-2006 school year, American Indian students represented 1% of the students who enrolled public schools in the U.S and the majority of the American Indian students enrolled in public schools were in the following states: Alaska (27%), Oklahoma (19%), Montana and New Mexico (11%), and South Dakota (10%) (NCES, 2008b). In the same academic year, of all the American Indian students, only 8% were found to attend schools funded or operated by Bureau of Indian Education.

Several researchers have addressed the ways to improve the education of American Indians such as implementing culturally relevant curriculum (Preston, 1991), applying Native American pedagogy (Hankes, 1998), and training teachers to meet the particular needs of American Indian students (Bradley, 1984). Application of culturally relevant or responsive education in American Indian students' education is critical in improving their achievement (Bradley, 1984; Nelson-Barber & Estrin, 1995). Culturally relevant education refers to teaching academic subjects (e.g., science and mathematics) in an appropriate cultural context. It requires linking pedagogy, culture and the subjects. Demmert and Towner (2003) point out that culturally based education has six elements:

1. Recognition and use of Native American languages
2. Application of pedagogy that includes cultural characteristics and the adult-child interactions
3. Application of teaching strategies that match with the traditional culture and ways of knowing and learning
4. Use of curriculum that reflects the traditional culture and emphasizes the spirituality
5. Participation of the native community (parents and elders) in schooling.

Students bring their cultures to the classroom, and it is very vital to connect school subjects to students' cultural values and their everyday life experiences. Nelson-Barber and Estrin (1995) suggest teachers of American Indian students teach each subject through embedding it into cultural activities. For example, the making of birch bark basket, weaving rugs, and use of beading play an important role in American Indian cultures. These activities can be used to teach geometry, number theory, and measurements. Healing plants, rice, maple syrup, and basswood are also integral part of American Indian cultures and can be used in formal science education. The curriculum that reflects American Indian students' culture can increase students' attitude toward the school and their academic performance (U.S. Dept. of Ed., 1991).

Teachers play an important role in student learning. NCES's 2007-2008 school and staffing survey results show that the American Indian/Alaska Native teachers represent only 0.5% of teachers in the U.S, while in Bureau of Indian Education schools, 39% of the teachers are American Indian/Alaska Native (NCES, 2009). The data demonstrates that most American Indian students' teachers are from a different ethnic group; they are most likely White since about 84% of the teachers are White in the U.S. (NCES, 2009).

Teachers of American Indian students should be facilitators and allow students to work on the activities or to solve the problems in any way that makes sense to students (Hankes, 1998). American Indian students' teachers should link the disciplines that they teach to students' existing knowledge, experiences, learning style, and culture that they bring into the classroom (More, 1989; Swisher & Deyhle, 1989). The teacher education programs should be designed to allow non-Native teachers to learn about culturally relevant pedagogy. Teachers should improve their knowledge on the norms and the values of the other cultures. It is necessary to recognize that the learning styles in cultures are different; thus, teachers should adapt their teaching methods for the students to meet their particular needs.

In addition to the cultural experiences and prior knowledge that students bring into the classroom, culturally relevant teaching also focuses on the way students learn and understand. American Indian students have different learning styles (More, 1989; Preston, 1991; Swisher & Deyhle, 1989). Their learning is dependent upon their environment, and they think in more relational styles rather than in analytic styles (Preston, 1991). In addition, they could not easily see the connection between the whole and its subcategories. Since most are visual learners, American Indian students learn best by observing their parents or elders (Pewewardy, 2002). Preston suggests that using experiential learning and cooperative learning activities can improve these students' problem solving abilities and can reduce their mathematics and science anxiety (Preston, 1991). Furthermore, Preston points out that workshops, after school, and weekend or summer school opportunities that emphasize hands-on activities and applications to real life situations can improve American Indian students' attitudes toward mathematics and science. It is well documented that American Indian students demonstrate high interest and success as they participate in activity-based science programs (Zwick & Miller, 1996).

It has been addressed that parental involvement is a necessary factor for American Indian students' achievement (NCES, 2008a; U.S. Dept. of Ed., 1991). Thus, parents of American Indian students are highly encouraged to be involved in the education of their children. However, few American Indian parents are involved in school, value education, or have high expectations for their children (NCES, 2008b). This is one of the main reasons for American Indian school failure and resistance to schooling: the clash of the culture of the parents/homes and the school. Students struggle with two cultures, and parent involvement can decrease the cultural differences between school and home (Reyhner, 1992).

The socio-economic factors also influence American Indian students' education. Particularly, in the reservations, a large percentage of parents are unemployed, and most students do not have access to materials such as computers, books, and magazines at home (NCES, 2008). Most schools with high population of American Indian students do not have necessary equipment and facilities such as science laboratories. Developing partnerships among the community, business, industry and colleges can provide financial support to improve the schools in reservations (U.S. Dept. of Ed., 1991).

STEM Integration into American Indian Students' Education

Integrating STEM into American Indian students' education is very critical. Most American Indian students do not adequately learn science and mathematics in elementary and secondary school since the main focus is on language arts in early grades. Even though most American Indian students speak only English at home, they have limited English proficiency. The vast majority of students successfully communicate with their classmates and teachers; however, they are behind in writing and reading. The National Indian Education study results on reading and mathematics achievement scores of 4th and 8th graders show that the average scores for American Indian students are lower than non-American Indian students in the U.S. (NCES, 2008b). In 2005, the science scores of 4th, 8th, and 12th grade American Indian students were lower than White students' scores (Grigg, Lauko, & Brockway, 2006). These findings show that American Indian students are not learning the mathematics and science needed to be successful, and therefore different strategies must be employed to engage American Indian students in STEM subjects.

The main factor that influences American Indian students' mathematics and science achievement is the cultural differences between home and school. In schools, Western views of mathematics and science are applied to teach these disciplines and this does not reflect what American Indian students know and believe. Bringing an American Indian view of mathematics and science into the school curriculum is necessary. Thus, the Bureau of Indian Affairs, for example, developed American Indian standards for science education. The standards align with the National Science Education Standards (National Research Council, 1996). The science concepts that are in the national science education standards modified to American Indian cultures. For example, the following (Figure 1) is the physical science content standard B for grades 5-8 (U.S. Department of Interior, Bureau of Indian Affairs, 1998, p.7).

Physical Science: Content Standard B
As a result of activities in grades 5-8, all Indian *students should develop an understanding of:*

- The principal of changes of properties in materials applied in the daily activities of early Indians, such as evidenced in the preparation of wood splints for basketry, the production of glue from the hooves of a deer, and the preparation of natural dyes. [properties and changes of properties in matter]
- How energy was transferred through the use of early Indian hunting tools such as the act of throwing a spear with an atlatl. [transfer of energy]

Figure 1. A sample of the American Indian standards for science education, which are adapted from the National Science Education Standards for use by American Indian cultures.

When teaching mathematics and science using effective materials such as manipulatives might help American Indian students understand science and mathematics easily. Integrating cultural stories into the instruction can be also helpful for students to learn these subjects since storytelling is an important part of their everyday lives. As Preston suggests (1991), teaching subjects through telling stories that students are familiar with can decrease American Indian students' anxiety to the school subjects. Giving human characteristics to animals, trees, wind, and soil in the stories have found to be very effective in American Indian students' learning (More, 1989). Another manner of helping students understand is through the use of contexts that are socially relevant to the students' communities (Rodriguez, 1998).

One way to integrate STEM into American Indian education is teaching science and mathematics using engineering as context. Science, mathematics, and engineering can be easily embedded in culturally relevant activities. Students can employ technology while completing the activities. To make STEM more culturally relevant to American Indian students, the innovative "Reach for the Sky (RFTS)" program at the University of Minnesota was developed as a summer and after school program. RFTS serves a specific group of American Indian youth – Anishinabe – who live on the White Earth Indian Reservation in Minnesota. The program is a three-year project funded by the National Science Foundation. The curriculum that is presented in this chapter was implemented in the second year of the RFTS program. The curriculum was delivered to approximately 70 American Indian students in the after school program of the RFTS project and was implemented in a two month long period in fall 2008.

CURRICULUM DESIGN

The curriculum was created to introduce American Indian youth to career opportunities in civil engineering, various civil engineering concepts, and the role of civil engineers in the technology driven 21st century. The curriculum emphasizes structural engineering and the curricular activities focused on bridges. The context of this curriculum was chosen due to the social relevance to the students of the 35W bridge collapse over the Mississippi River in Minnesota on August 01, 2007. This devastating tragedy impacted many families in Minnesota, and it brought attention to the nation's other bridges. The media has presented massive information regarding the 35W bridge collapse and structural deficiencies of many other bridges.

The design of the curriculum is theoretically aligned with *sociotransformative constructivism*. Curriculum design from a constructivist perspective focuses on the social construction of learning and enables students to learn through collaboration (Hand & Treagust, 1991). Sociotransformative constructivism implies that the learning takes place with the perspectives of dialogic conversation, metacognition, reflexivity, and authentic activity (Rodriguez, 1998). The bridge building activities allowed students to actively engage in their knowledge construction as they learned the concepts through hands-on activities (constructivism). Demonstrations, computer simulations, and videos were employed to increase students' engagement. In addition, all students were asked to keep journals, written as *blogs,* to reflect on their learning (metacognition). The designers of the curriculum, the authors of the chapter, created a restricted online social network with content management capabilities (*Ning* – http://www.ning.com/) to deliver the curriculum and allow students to have interactive experiences with technology and with the instructors and designers (dialogic conversation). Only the students, teachers, and the designers of the curriculum had access to the RFTS Ning site. The website enabled students and teachers to share curricular artifacts and their experiences with the curriculum (reflexivity). Finally, the setting is around the very socially relevant context of the bridge collapse, which allowed for discussions of ethics, beliefs, etc. related to the collapse, and what role civil engineers play, as well as the students themselves, when tragedy strikes (authentic activity).

The curriculum included six individual lesson plans, each to be completed in one to three 50 minute long class periods. Each lesson plan included a student activity worksheet that students completed at the end of the activity. In addition, lesson plans included extensive content information for the teachers to read before the instruction. When implementing the curriculum, teachers followed the detailed procedure for each activity during the classroom instruction. Lesson plans also provided options for teacher to extend the lessons. The lesson extensions required students to conduct an Internet search on the specific part of the content that was discussed in the lesson and then present the findings in the classroom. The curriculum included five main parts: exploring civil engineering, bridge construction, different types of bridges, designing the least expensive bridge, and the bridge replacement Model-Eliciting Activity (MEA).

Exploring Civil Engineering

In the first part of the curriculum, students explored civil engineering and gained an understanding of the engineering design process – ask, imagine, plan, create, test, improve (Museum of Science Boston, 2009). First, the students watched short video clips that explored civil engineering as a career. These video clips were uploaded onto the Ning site by the curriculum developers. Students were encouraged to search for different video clips on the Internet and to add them onto the Ning site.

Students then discussed different types of civil engineering projects found in their community and how to become a civil engineer. There were two purposes in this: (1) to help the students connect the content of the curriculum to their everyday lives, and (2) to encourage the students to consider engineering as a career. Following these introductory activities, students engaged in deep discussions about the 35W bridge collapse. This context connects activities in the summer 2008 RFTS program to the curriculum in the after-school program in fall 2008. During the summer program, the students visited the new 35W bridge construction site to observe the new bridge construction. Civil engineers from the company building the new 35W bridge gave presentations about the structure of the old and new bridge to the students. This connection and the resulting content were revisited in fall 2008. Through analyzing the 35W bridge collapse and the design of the new bridge, students increased their knowledge about the different bridge structures and also engaged in the curriculum activities. When the first part of the curriculum was finished, students wrote short essays describing a career in civil engineering. They posted their essays on the Ning site. The curriculum developers provided feedback to students on their essay.

Bridge Construction

In the second part of the curriculum, students built model bridges following engineering processes. These activities were based on the bridge curriculum in the *Design It!* series

(Hutchison, McCulloch, & Zubrowski, 2002). Through building paper bridges, students experienced bridge structure as they learned about science concepts such as balance and forces (e.g., tension, compression, torsion, shear, and flexure). At this stage, teachers used various demonstrations with paper towel tubes to help students understand these abstract concepts. They then discussed how different forces act when the length of a beam and shape (e.g., round, square, etc.) of columns changed. Students looked at the various pictures on the Ning site to see bridges with different types of columns. Students then built beams and columns from copy paper with the goal of creating the strongest bridges (Figure 2), and they participated in a small competition where they put weights on their bridges to find the bridge formation that is most structurally stable. After the competition teachers provided enough time for students to redesign their bridges to make them stronger.

Figure 2: Students building paper bridge

Figure 3. Students testing their K'NEX bridge.

Different Types of Bridges

The third part of the curriculum focused on different types of bridges (beam, truss, arch, suspension, and cable-stayed) and how different types of forces act on each type of bridge. Groups of three to four students built all five types of bridges from the K'NEX™ Education set *Bridges: Introduction to Structures.* The students tested their bridges (Figure 3) by putting weights on them to find how strong they were and what forces were acting on them. When they built all five types of bridges they discussed the similarities and differences among different types of bridges. During that time, teachers showed pictures of different types of well-known bridges and asked questions such as, "What factors might engineers consider while designing these bridges? What were these bridges designed for? What are the main structural differences among these bridges?"

Designing the Least Expensive Bridge

In the fourth part of the curriculum, students used the West Point Bridge Design (WPBD) Software 2007. It is free software and can be downloaded from http://bridgecontest.usma.edu/. The software allows students to build various types of truss bridges (e.g., through truss and deck truss) and test their designs. Figure 4 shows a screen shot of a truss bridge design in WPBD. Students engaged in the engineering design process by utilizing this bridge building software that has a real life estimator for cost analysis and structural analysis. Groups of two students designed their truss bridges. Students first chose the possible site configurations such as abutments, deck, span, and excavation for their bridge. They then decided what type of truss bridge they would use in their design. Next, they built their structural model. When students drew joints and connected the joints they completed their preliminary design. The next step was for the students to choose the material (e.g., carbon steel), cross section (e.g., solid bar), and size of the material (e.g., 120 mm). Their choices of those variables affected the cost and the stability of their bridge design. Students attempted to design the least expensive bridge, but they were supposed to build a design that was strong enough to carry the traffic loads which was described in the program. When students completed the load test, they found whether or not their bridge design failed the load test. If their bridge design failed, they increased the strength of the members of their bridge while considering the cost. When all groups completed their optimal bridge design, they presented their design to the class.

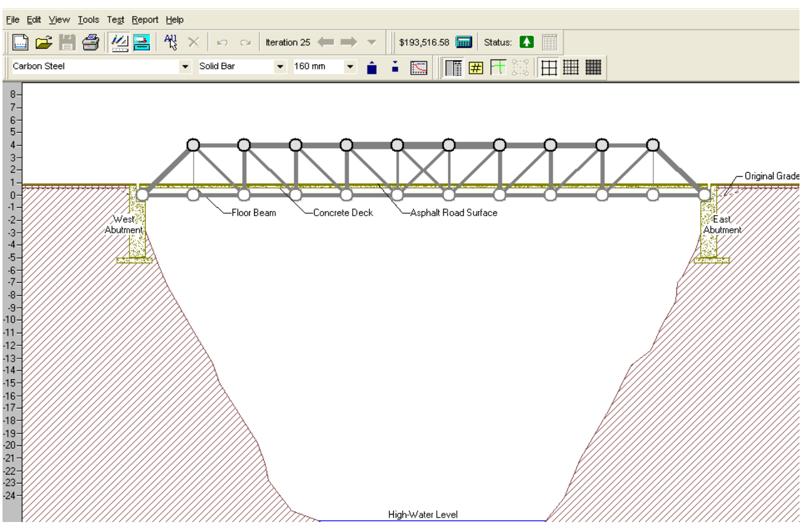

Figure 4: A truss bridge design.

Bridge Replacement Model-Eliciting Activity

The final part of the curriculum had students engage in a Model Eliciting Activity (MEA), which is a problem-based design activity focusing on solving real world problems (Diefes-Dux, Moore, Follman, Imbrie, & Zawojewski, 2005; Moore, 2008). Students worked in groups of three to four to create a procedure to choose the type of bridge design to replace a bridge, which is structurally similar to the 35W bridge and has structural deficiencies. Students made construction decisions, developed skills in critical thinking and teamwork, and experienced the engineering design cycle (see appendix for more information about the bridge replacement MEA).

TEACHER TRAINING

The teachers of the after school program were trained on how to deliver the curricular unit by the curriculum designers. The curriculum was implemented in three school sites with two teachers collaboratively teaching at each site. Six teachers participated in the trainings. During the two four-hour long trainings, teachers as students experienced all the curricular activities (split between the two trainings). In addition, teachers learned how to use the RFTS Ning site by designing their own blogs, creating discussion boards, and uploading pictures and videos. After the completion of the first training, teachers started to implement the curriculum in their schools. Teachers regularly communicated with the curriculum designers through the Ning site during curriculum implementation. The necessary lesson plan modifications were discussed and changes were made. Some teachers asked students to complete extra activities such as an internet search on the class material. All these plans were discussed among teachers and the curriculum designers before being implemented in the classroom. Teachers also informed the curriculum developers of the effectiveness of the lessons on the level of student engagement and time constraints.

EVALUATION OF THE CURRICULUM

To investigate the effectiveness of the curriculum on enhancing American Indian students' interest and understanding of civil engineering concepts, a research study was designed. A mixed-method research methodology was employed in the study (Creswell & Clark, 2007). Various data collection instruments were used: students' pre- and post-tests, blogs, and MEA procedures, and teachers' reflection journals. Clements's *Curriculum Research Framework* (CRF) (2007) was used to structure this curriculum study development. Clements defines curriculum as "a specific set of instructional materials that order content in order to support pK-12 classroom instruction" (p. 36). Using Clements' framework, the research followed a three-phase process: (1) use existing research that allow the curriculum development team to apply what is already known to the curricular modules, (2) revise curricular modules in accordance with models of children's thinking and learning within the specific content domain, and (3) conduct formative and summative evaluations in classroom settings. Stages 1 and 2 were completed prior to the implementation of the curriculum reported in this paper. The curriculum developers used prior research and pilot testing as our means to complete these stages. The evaluation of the curriculum is the focus of the research here. Stage 3 is comprised of formative research and summative research. This chapter aims to report the formative research of stage 3. Future research will report on the summative research on this curriculum.

The qualitative data is reported in the form of excerpts of student classroom artifacts and teacher responses to reflection questions. This data is being used in the formative stages of the research to allow the project staff to revise the curriculum. The quantitative research is a paired t-test (Muijs, 2004) to determine if the students' pre- and post-test data differs significantly. Here, a $p = 0.05$ cutoff level of significance was used to determine statistical significance.

Of the 64 students, 27 completed both pre- and post-tests. 30 students completed only the pre-test and 7 students completed only the post-test. The pre-post content test was developed based on the content being taught in the curriculum. It covered structural engineering content including structural similarities and differences in five different types of bridges (i.e., beam, arch, truss, suspension, and cable-stayed) and strengths and weaknesses of these different bridge structures. In addition, the test was designed to capture students' understanding of science and mathematics concepts related to structural engineering. The science concepts in the test included the forces that act on a bridge and the mathematics concepts focused on geometrical shapes of columns and the effect of bridge pier shape on the stability of bridges. The pre- and post- tests were equivalent and included same number of true false questions, matching questions, fill in the blank questions, and open ended questions. The pre-post test scores of the students were graded based upon percentage of correct answer. Mean score for the pre-test is 29.3 and mean score for the post-test is 51.8 out of a total of 100.

The hypothesis test is as follows:

H_0: The means of the pre- and post-tests are equivalent.
H_a: The mean post-test is greater than the mean of the pre-test.

Rejection of the null hypothesis comes when the differences between the means are statistically significant ($p < 0.05$). This is a paired test of significance. The scores of the 27 students who completed the pre- and post-test were compared. Table 1 shows the results of the paired t-test. The students' post-test scores show a higher degree of understanding of the civil engineering concepts than the pre-test. The null hypothesis was rejected ($p<0.0001$) in favor of the alternative hypothesis showing a significant difference between pre- and post-test scores. The quantitative data analysis demonstrates that the curriculum has positive impacts on the students.

Table 1: Paired t-test.

	N	*M*	*SD*	*t*	*df*	*P*	*Cohen's d*
Pre	27	29.3	14.7	4.9	52	‹.0001	1.19
Post	27	51.8	22.2				

The students’ blog entries provided information on their level of engagement in activities. Most students indicated that they enjoyed building bridges. Before receiving the curriculum, almost all students could not explain the job requirements of civil engineers, but at the end of curriculum implementation, each student could provide a reasonable explanation of the roles and duties of civil engineers in society. Some sample responses are:

> “Civil engineers design buildings, bridges, and roads.”

> “They build bridges, roads, tunnels, and subways.”

> “I think that civil engineers build buildings. They built the Golden Gate Bridge. They also built some of the tallest skyscrapers, including the Empire State Building!”

> “Civil Engineers are people who design, work, (of course…) and also they plan. They fix a lot of things, like: bridges, (most common) buildings also. I also think civil engineers are very interesting now that I know about them...At first I didn't even know about civil Engineers.”

The following quotes demonstrate student interest in becoming engineers:

> “I liked looking at pictures and watching videos of civil engineers and bridges, I think engineering is about building cool stuff.”

> “I want to be an engineer.”

The analysis of MEA responses shows that students’ increased their knowledge about bridge structures. The examination of MEA responses provided information about how well the students understand the concepts that were presented through the curriculum. Students’ responses demonstrate that students thought critically, collaborated, analyzed, and synthesized given information, and used that information to solve the real engineering problem. In their responses, students specifically explained what particular type of bridge they would choose to replace the bridge that is given in the MEA. Examples of student answers are below (including Figure 5).

> “I think an arch bridge would work because it lasts a long time and it is built for long distances. The arch would be better because the bridge is made out of stone and a lot of stone is found around Minnesota. But the problem is that the arch is hard to build and cost a lot. They look fun to build.”

> “I want build a truss because a truss bridge is a strong bridge it stand strong wind not like suspension bridge. The truss bridge's span is going to be around 2,000feet long at least.”

> “I would like to build the arch bridge. I want it to be kind of like 10th Ave. bridge, 2175 feet, 101 feet below and it would maybe as much as the 10th Ave bridge. I want it to have four lanes. It would difficult to build though. You could use the rocks from Minnesota. It would be beautiful and last a long time like the 10th Ave bridge did. Arch bridges are very strong. It has materials that are strong such as stone, cast iron, timber, and steel. It will be very helpful for

all the people that live in St Cloud. I think it will cost about nine or ten million dollars. The 10th Ave. bridge cost about that much."

> To: Mn/Dot
>
> From: Engineering team
>
> We chose the truss bridge because we looked at a similar bridge in Dubuque, Iowa. The Iowa bridge had two lanes and the Iowa bridge was twice the size. The cost of the Iowa bridge was 2.5 million at 2000ft. Our bridge needs 5foot sidewalks but it is only half of the size. We felt that the Iowa bridge has lasted over 100 years. It must be a strong safe bridge. We would estimate the bridge cost 1.75 million dollars with the two lanes and the 5 foot sidewalks.
> Procedure:
> 1. The first thing would be the cost of all the bridges
> 2. We thought it would be safe and strong
> 3. How much weight can support the bridges

Figure 5. One team's solution to the bridge replacement MEA.

Teachers' reflection papers provided valuable information regarding the effectiveness of the curriculum. Some teacher reflections on the curriculum are:

> "Getting our students to think about engineering as a career is great. The understanding that engineers are problem solvers is a wonderful lesson all by itself. They enjoyed exploring what civil engineers do too."

> "All of the students were interested in the topic of bridges. All of the students gained from the curriculum…They all enjoyed the time on the computers and the time building with the K'NEX. The objectives of the bridge building activities were all met but at very different levels for different students."

> "It's a great curriculum. It gives kids a lot of great knowledge and experiences. It is a great introduction to engineering."

> "I felt that the students were engaged most of the time. They had a lot of fun when we started the curriculum…"

> "I thought that the curriculum was fun and the kids had a good time building the bridges. I was disappointed that the computer program [WPBD] did not work at our school."

CHALLENGES FACED DURING THE IMPLEMENTATION

Originally, the curriculum was designed to implement in a two and a half week long period – one hour of instruction every school day. However, in the after school program students met four days a week for one and a half hours. The curriculum could not be completed in the planned time period mainly because of the time constraints put on teachers for other unrelated parts of the after school program and because of computer related issues that teachers experienced. Curriculum activities required regular computer use; however, the access to the computer labs in schools was challenging. Because it is an after school program, little technological help was available to teachers to overcome computer-related problems. For example, the WPBD software works only on PC. Two of the schools have only Macs so cross-platform software programs needed to be downloaded to these computers. While teachers made the extra effort to be able use the software program in the program, one school was not able to get the WPBD software to work.

Creating a sustainable community in the RFTS Ning site was also a challenge that the curriculum designers faced. At the beginning of the curriculum implementation, the quality of students' blog entries was below expectations. Instead of using Ning to give responses to the content related questions or participating in the content focused discussions, students used Ning to socialize with their classmates. Thus, teachers strongly encouraged students to be reflective in their learning process and to participate in online discussions. Students gradually became more interested in forums and discussions. However, some students found it difficult to engage in the forums or discussions since they had under-developed writing and reading skills.

Attendance was another challenge that teachers faced while implementing the curriculum. Approximately one fifth of the students attended the program for the full duration of the curriculum implementation. The rest of the students came to the program at various times. Thus, the vast majority of the students did not post blogs regularly or complete all of the parts of the curriculum.

A final challenge revolved around the location of the curriculum developers and the schools. Since the school sites and the university are far away from each other, the university educators (curriculum developers) could not make as many observations or provide as much on-site help as was needed or wanted. However, teacher training, detailed lesson plans, and continuous communication between teachers and the curriculum designers allowed teachers to successfully implement the curriculum.

EVIDENCE OF SUSTAINED LEARNING

This curriculum was implemented in the after school portion of the RFTS program. The summer program is separate from the after school program, so it is important to note that twelve of the students who received the bridge curriculum in the RFTS afterschool program in fall 2008 also attended the summer school in summer 2009. Like the afterschool program, the summer school program aims to increase students' knowledge and understanding of STEM and increase their interest in STEM careers. The first day of the 2009 summer school program, all students completed a "draw an engineer test" (Knight & Cunningham, 2004). In this activity, students showed their knowledge about engineers through their drawings. They also provided written responses to the following question: "What do engineers do when they are working?" The analysis of students' drawings shows that students who participated in the afterschool program have well-developed understanding of engineering, particularly civil engineering. From twelve students who attended the afterschool program, ten of them drew a civil engineer; the remaining two drew a mechanical engineer who fixes cars or trains. Students who drew a civil engineer used the words “make”, “build” and “design” to explain what civil engineers do. The following (Figures 6 and 7) are the images of the drawings of two students and their responses to the question, “What do engineers do when they are working?”

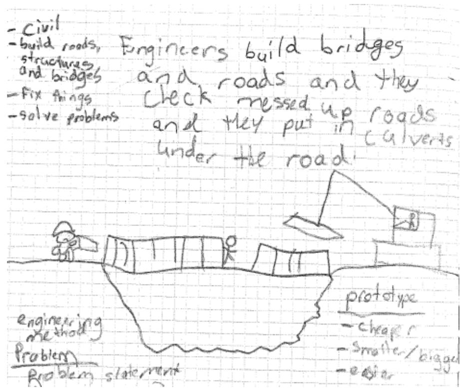

Figure 6. Image of a civil engineer.

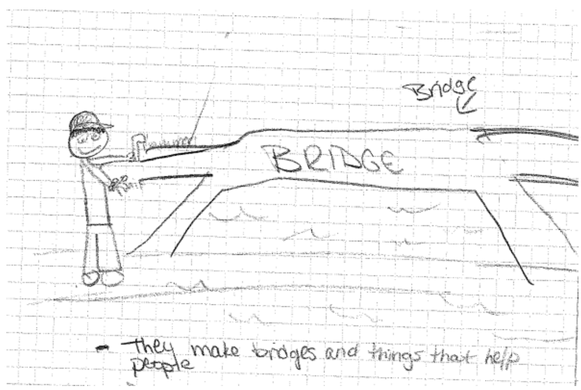

Figure 7. Another image of a civil engineer.

CONCLUSION

Given the growing emphasis on STEM education, this curriculum provides valuable information for university educators, researchers, and K-12 educators interested in the best practices in STEM education. The curriculum sheds new light on the effective design and implementation of integrated science, technology, engineering, and mathematics education curricula. To enhance STEM education in K-12 in diverse settings, a strong emphasis should be given to integrating engineering with other STEM disciplines in a contextual manner.

As evidenced by the data, students learned how to apply mathematics, science, and technology to engineering problems through engaging with the curriculum activities. The curriculum activities greatly increased students’ knowledge and level of interest in engineering as shown in students' pre- and post-test results and blog entries. Further, it was found that hands-on, inquiry-based activities enhanced students' motivation. Thus, to increase the knowledge and skills of American Indian students in STEM disciplines teachers should apply student-centered instruction based on sociotransformative constructivism.

The bridge curriculum was particularly designed for an after school program, but with modifications, it can be easily implemented in a regular school program. As a next step, the designers of the curriculum plan to formalize the curriculum and implement it in an engineering education focused inner city school.

ACKNOWLEDGMENT

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APPENDIX

Model Eliciting Activity-Part A
Bridge Replacement-Individual Activity

Read the following information and individually answer the questions that follow.

35W Bridge Collapse

Background material adapted from Mn/Dot Bridge website (http://www.dot.state.mn.us/bridge/)

The Interstate 35W Mississippi River Bridge in Minneapolis collapsed on August 1, 2007. The eight lane bridge was Minnesota's busiest, carrying 140,000 vehicles a day. This deck steel truss bridge was 1,907 feet long and had 14 spans. It was open to traffic in 1967 and expected to be reconstructed in 2020-2025. The bridge was inspected every two years until 1993; after that it was inspected every year.

Starting in 1997, deficiencies were demonstrated in inspection reports. Mn/Dot attempted to improve the condition of the bridge through bridge span rehabilitations. Furthermore, in 2001 Mn/Dot worked with civil engineers from University of Minnesota to evaluate the fatigue stress within the truss. Following the field tests, the civil engineers recommended that fatigue cracking was not expected to be a problem in the truss but reported that some critical locations of the trusses had high stress and some girders were distorted. The bridge's last inspection was completed in June 15, 2006. As a result of comprehensive analysis on fatigue and fracture structure recommended supporting the critical 52 truss members.

During the 35W bridge collapse, 13 people were killed and more than 100 injured. The investigations on the collapsed bridge continue. Mn/Dot has investigated every single detail to find what caused the bridge collapse. It has been considered that *gusset plates* in the center span and the extra weight from construction may have contributed to the tragedy. The gusset plates are steel plates that tie steel beams together on a bridge. These are a very important structural component of truss bridges. However, it should be also considered that gusset plates are not the only structural components in truss bridges; other critical parts of the bridge might have deficiencies. In addition, extra weight may not be a main factor for the bridge collapse since the bridge had less than its usual traffic at the time of the collapse. Half of the lanes were closed for the repair when the bridge failed.

Individually

Watch the video of 35 W bridge collapse from http://www.youtube.com/watch?v=osocGiofdvc or go to http://reachforthesky0809.ning.com

Generate a list of factors you believe are involved in the 35W bridge collapse.

Generate a list of factors that you need to consider when designing a bridge.

Once you have finished your individual response, request the memo from Mn/Dot. Read the memo individually and then let your instructor know that you are ready to proceed.

INTERNAL MEMO

To: Engineering Team
From: Mn/Dot
Re: Bridge Design

After the 35W bridge collapse, Mn/Dot has focused attention on the condition of other bridges in Minnesota. Mn/Dot conducted recent inspections on bridges in the Minnesota and found that there are 1,907 bridges that are structurally deficient. As a result of recent inspections, Mn/Dot shut down another bridge in March 2008. Originally, the bridge was scheduled for replacement in 2015, but Mn/Dot inspectors found critical deficiencies during the inspection. The bridge has a similar design configuration as 35W Bridge and it is located over the Mississippi River in St Cloud. Mn/Dot plans to replace the bridge soon. The new bridge will be located in the same place as the old one. It will carry a highway and run east-west. The length of the bridge will be approximately 900 feet. The bridge deck should have two lanes and should also have 5 ft wide sidewalks along both sides of the bridge.

Starting with the St. Cloud Bridge, Mn/Dot will replace many of the bridges that have been found to be structurally deficient. Because so many bridges are going to be replaced, Mn/Dot needs a procedure for comparing different type of bridges and choosing the right type of bridge to build across each span. Mn/Dot is asking you to create this procedure. First, your team should decide on the least expensive and safest bridge to replace the St. Cloud Bridge. Pay attention to how you made this decision because we also need you to create a procedure to make the same type of decision in other locations around Minnesota. Mn/Dot will use your procedure to replace the St Cloud Bridge and then other bridges. Please find the enclosed information regarding the types of bridges that Mn/Dot plans to build—truss bridge, arch bridge, suspension bridge, and cable-stayed bridge. In addition to the information about the major types of bridges, Mn/Dot also has provided you two examples of four types of bridge in the U.S. You may need to use this information as a starting point to determine your procedure for selecting the new bridge design. Please respond in a letter to Mn/Dot explaining which bridge is right for the St. Cloud span and why you chose it, and provide them with a method to make the decision of which type of bridge to use to replace any bridge in Minnesota.

Hwy. 23 bridge in St. Cloud, MN.

Thank you.
Peggy Abrams

Model Eliciting Activity- Part B
Bridge Replacement- Team Activity

Read each team member's individual list of factors that need to be considered when designing a bridge.
Reread the Memo as a team.
Write the body of a memo to Peggy Abrams at Mn/Dot that includes:
- A clear explanation of what type of bridge you decided to build in St. Cloud and why you made that decision.
- A detailed explanation of your team's general procedure for choosing the best bridge type to build across any span and indicate how Mn/Dot can use this procedure to replace other bridges in Minnesota.

Table 1. Different Types of Bridges

Bridge Type	Advantages	Disadvantages	Span range	Material	Design Effort
Truss bridge	-Strong and rigid framework -Work well with most applications	-Cannot be used in curves -Expensive materials needed	Short to medium	Iron, steel, concrete	Low
Arch bridge	-Aesthetic -Used for longer bridges with curves -Long life time -Very strong	-Abutments are under compression -Long span arches are most difficult to construct -Relatively expensive	Short to long	Stone, cast iron, timber, steel	Medium
Suspension bridge	-Light and flexible -Aesthetic	-Wind is always a concern -Expensive to build	Long (up to 7,000 feet)	Steel rope and concrete	High
Cable-stayed bridge	-Fast to build -Aesthetic	-Stability of cables need to be considered for long span bridges	Medium (500-2,800 feet)	Steel rope and concrete	High

Table 2. Examples of four major types of bridges

Bridge Name	Location	Bridge Type	Total length	Clearance below	Lanes	Constructability	Life time	Cost (Present value)
Hennepin Ave Bridge	Over Mississippi (Metro area)	Suspension bridge	1037 feet	37 feet	6	Easy	Fairly long (Built in 1990)	$100 million
Golden Gate Bridge	San Francisco, CA	Suspension bridge	8,981 feet	220 feet	6	Difficult	Fairly long (Built in 1937)	$212 million
10th Ave Bridge	Over Mississippi (Metro area)	Arch bridge	2175 feet	101 feet	4	Difficult	Long (Built in 1929)	$ 9 million
Stone Arch Bridge	Over Mississippi (Metro Area)	Arch bridge	2100 Feet	24.4 feet	Bike and pedestrian trials	Difficult	Long (Built in 1883)	$15 million
Greenway Bridge	Minneapolis MN-55, Light Rail Line	Cable-stayed bridge	2,200 feet	20 to 27 feet	Bike and pedestrian trials	Easy	Fairly long (Built in 2007)	$5.2 million
Arthur Ravenel Jr. Bridge	South Carolina, crosses Cooper River	Cable-stayed bridge	13,200 feet	186 feet	8	Easy	Fairly long (Built in 1929)	$ 62 million
John E. Mathews Bridge	Florida, crosses St. Johns River	Truss bridge	7736 feet	152 feet	4	Difficult	Short (Built in 1953)	$ 65 million
Eagle Point Bridge	Iowa	Truss bridge	2,000 Feet	70 feet	2	Difficult	Short (Built in 1902)	$2.5 million

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Chapter 12

SCIENCE CURRICULUM DEVELOPMENT IN ONLINE ENVIRONMENTS: A SCALE TO ENHANCE TEACHERS' SCIENCE LEARNING

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ABSTRACT

A science curriculum should emphasize the nature of science, and foster the development of scientific habits of mind within the student population. This is particularly important within science content courses designed for practicing teachers, who will teach the subject matter as well as model scientific methods within their own classrooms. Previous science educational research revealed that inquiry-based and active learning strategies in traditional classrooms can result in meaningful student learning, but the translation of these methods in online environments is far less researched. Therefore, we focused on science curriculum development in the online environment by which science content, the nature of science, and scientific habits of mind can be conveyed to practicing teachers.

Through numerous semesters (N = 10) and a variety of online science courses (N = 6), our research demonstrated that online science curriculum development proceeds successfully through incorporation of **SCALE**. The online science curriculum should focus upon **S**elf-directed autonomous activities, **C**ommunity-based learning, both within an online environment and within the teachers' local areas, **A**ctive-learning strategies that move practicing teachers beyond the confines of the computer environment, and **L**ocal **E**nvironment incorporation for easy access and relevance to individual online learners. The **SCALE** method allows for interdisciplinary and integrated science curriculum in a variety of online science environments. The resultant content is consistent with the theory

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of human constructivism, which stresses that "less is more," and it emphasizes meaning over memorization, quality over quantity, and understanding over awareness.

SCALE can be accomplished through autonomous informal activities utilizing teachers' local field sites, history of science investigations, online community discussions, and interdisciplinary topic portals for self-directed research and classroom implementation. Our mixed methodology research investigations indicate that more successful learning occurs within an online science **SCALE** curriculum. **SCALE** may also result in more positive teacher attitudes toward online science courses.

INTRODUCTION

Online learning continues its expansion of the higher education market. While students often enroll in online courses because of convenience and autonomy, research studies confirmed that online courses can be effective learning environments, dependent upon instructional delivery (Means, Toyama, Murphy, Bakia, & Jones 2009; Tallent-Runnels, Thomas, Lan, & Cooper, 2006). Some research studies concluded that online delivery of content may be more effective than traditional classroom delivery (Maki, Maki, & Whittaker, 2000), especially when measured by conceptual assessment items (Parker & Gemino, 2001).

Many practicing science teachers choose online environments for furthering their science content knowledge, as attested by the success of several distance learning degree programs. Research that focused specifically on science learning affirmed that online instruction can be effective (King & Hildreth, 2001; Johnson, 2002). However, most online research studies investigated course content, and did not necessarily focus on active learning strategies. Science educators generally acknowledge that a science curriculum should emphasize the nature of science and foster the development of scientific habits of mind within the student population, but how this is best accomplished in the online environment has not been fully researched, particularly with a practicing teacher population. Distance learning classrooms bring new and additional challenges for effective education, and online instruction encounters different constraints for successful science content delivery.

Although discipline-specific content is important within each course, student inquiry and decision-making are processes that reveal—and reinforce—the methods by which the body of science progresses. Science education research studies reported successful outcomes with inquiry-based and active learning strategies in traditional classrooms, but little investigation has been conducted on the translation of these methods for online environments. Therefore, our research into science curriculum development for practicing teachers focused upon identifying the science content as well as the methods by which the nature of science and scientific habits of mind can be conveyed in the online environment with a geographically widespread teacher population.

ACTIVE LEARNING, INFORMAL ENVIRONMENTS, AND LOCAL ENVIRONMENTS

When designing a science curriculum, developers must keep in mind methods by which content will be delivered, as well as the differences that exist in various learning environments. Many research studies affirmed the benefits of active and student-centered learning (McConnell, Steer, & Owens, 2003; Lawrenz, Huffman, & Appeldoorn, 2005; Michael & Modell, 2003). Settings outside the traditional classroom, or informal educational environments, also can provide rich learning opportunities in science (Anderson, Lucas, & Ginns, 2003). Informal field experiences supply environmental context and land ethic (McLaughlin, 2005). Field experiences also can provide holistic experiences that students retain (Bernstein, 2004), and have resulted in significant science concept gains (Elkins & Elkins, 2007). Furthermore, research investigations that probed students' sense of place revealed that the *local* landscape had the greatest effects on perception, content-specific knowledge, and affective responses toward the subject (Clary & Wandersee, 2006; Wandersee, Clary, & Guzman, 2006). Past research, therefore, supports active learning strategies that move students beyond the confines of traditional classroom walls, and that incorporate local environments with which students are most familiar. Can active learning strategies and local environments be incorporated in *online* environments within a successful science curriculum? With geographically diverse student populations, "local environment" has a different meaning for most students, and few commonalities exist.

History of Science and Nature of Science

The history of science has been recognized as an important component in science classrooms to convey the nature of science to our students. Attesting to its importance, the National Science Education Standards included the "History and Nature of Science" as one of the eight categories of content standards. The incorporation of the history of science in the classroom can reveal science as an interesting endeavor (Matthews, 1994), humanize the curriculum (Jenkins, 1989), and demonstrate how scientific knowledge is restructured and modified as new data and research materialize (Duschl, 1994). Through the history and philosophy of science, instructors can confront misconceptions of the linearity of scientific advancement and the streamlined perception of "final form" science (Duschl, 1990). The history of science reveals scientists' personalities and inherent biases, but importantly demonstrates that the scientific community triumphs through the correction of false claims and exposure of poor research (Clary, Wandersee, & Carpinelli, 2008). Educational research studies reported positive benefits with the incorporation of the history of science in science classrooms (Abd-El-Khalick & Lederman, 2000; de Hosson & Kaminski, 2007).

Therefore, it is important that the history of science and the nature of science be included within the science curriculum, even within an *online* science curriculum. We researched different methods by which an online science curriculum could be implemented, including effective science content delivery via active learning strategies, inquiry-based learning, informal educational sites, and the history of science. Our research is guided by the theory of human constructivism (Mintzes, Wandersee, & Novak, 1998, 2000; Gowin, 1981), which emphasizes that "less is more." Science instruction should proceed by developing a curriculum that emphasizes meaning over memorization, quality over quantity, and understanding over awareness. We sought to build an online science curriculum that provided meaningful learning experiences for our online students, who are practicing teachers. By incorporating a "less is more" strategy, we provided student-directed learning opportunities that included each teacher's local environment. We also tried to include active learning opportunities wherever feasible, and we interjected the history of science to illuminate the nature of science for the teachers.

METHODS

Teachers with whom we work are enrolled in an online master's degree program in the geosciences. A research university in the southern US administers the program entirely online, with the exception of a capstone field course at the conclusion of the program of study. The general structure of the online courses is such that course content is administered through assigned readings, DVD-recorded or video-streamed lectures, and instruction via e-communication and online discussion boards.

There are several assessment methods within each course, including unit quizzes, quarterly homework assignments with accompanying evaluations, and timed midterm and final examinations. The unit quizzes, of low point value, are utilized as formative assessments. Quizzes encourage students to investigate the assigned content, assimilate the concepts, and take positions on the interpretation and application of the material. The quizzes are used also as pacing tools to ensure that students remain active within each online course on a weekly basis. However, students are allowed to work up to three weeks ahead of an assigned unit's due date.

Through multiple semesters (N = 10) of assorted online science courses (N = 6), we refined the amount and type of discipline-specific content delivered to practicing teachers enrolled in the courses. We investigated delivery methods of content, and utilized examination scores and anonymous teacher survey responses to determine successful combinations of content and activities. Anonymous survey comments, collected at the end of every semester in every online course, especially guided our modifications of the course content and delivery in future semesters. The online science courses involved included those required for the master's degree program (Geology: Processes and Products, Geology: Earth and Time), as well as elective master's courses and Master's Plus 30 courses (Geology of North America, History of Life, Earthquakes and Volcanoes, and assorted independent studies).

In our curriculum development, we experimented with the methods by which science course content was delivered, and attempted to personalize science content and delivery based upon the unique composition of the student body. However, active learning and inquiry-based study were implemented where possible, and based upon our early online science research results (Clary & Wandersee, 2008a), we incorporated teachers' local landscapes. Our mixed methodology approach (Tashekorri & Teddlie, 1998) utilized quantitative comparisons where feasible, as well as qualitative investigations via content analysis of teachers' survey responses (Neuendorf, 2002) and analysis of teachers' unstructured, informal interviews (Chi, 1997).

Student-Directed Research Investigations

The pioneer research asssignment. For assimilation and application of content material, student-directed and inquiry-based research in informal environments was first utilized in 2006 (Clary & Wandersee, 2008a). The course in which it was implemented, History of Life, is an online paleontology course. The course is offered every Spring semester as a second-year elective to master's students enrolled in the Teachers in the Geosciences program. It is also a course offering in a Master's Plus 30 continuing education program. Therefore, all teachers enrolled in the History of Life courses have familiarity with online environments and the typical structure of the online science courses.

For the quarterly homework assignments, "typical" laboratory manual activities, assigned readings, and internet investigations were assigned for the first three quarters' homework. However, for the fourth—and last—quarterly homework assignment, our enrolled teachers were instructed to plan their own field fossil investigations: Teachers had to locate, retrieve, photograph, and identify fossils from their local field areas. Each teacher was responsible for procuring 12 fossil specimens, representing 12 different species and three phyla. Teachers photographed each specimen using a red pencil, and the university logo for scale. (Five teachers were offered alternative assignments with informal education site investigations when they encountered difficulty in the field with heavy snow pack, or had documented physical or medical limitations that prohibited field activity.)

The second part of the self-directed research project involved *application* of the teachers' research in their individual classrooms. Each teacher was responsible for designing activities, using the fossils s/he procured, in her/his classroom. Requirements also included 1) identification of state content standards and learning objectives that the activities addressed; 2) incorporation of active learning strategies for their own students; and 3) assessment tools for their classrooms.

For successful completion of the assignment, teachers had to investigate their local environments, determine where fossils could be legally procured, secure permission, and collect. The instructor was available to answer questions, and guide the teachers to local resources (such as state geological surveys, local fossil guides, and/or local experts). The instructor and the student's teacher-colleagues were available to help identify problematic specimens: Photographs could be posted on an electronic discussion board, and the class offered suggestions for successful identification. Although this assistance was available, the assignment's direction was determined by each individual teacher, based upon his/her local environment.

We collected teachers' opinions about the self-directed research investigation—as well as other aspects of the course content implementation—via an anonymous end-of-semester electronic survey. Although some teachers demonstrated misgivings and hesitation when the assignment was first posted, all problems were eventually rectified. Even the most vocal opponent to the initial assignment became a convert for student-directed research within local environments by the end of the semester.

Expansion of student-directed research. Based on the success of the first student-directed, active learning fossil investigations in each teacher's local environment, we expanded our student learning experiences. Other student-directed research opportunities were developed, and implemented in other online classrooms.

In later semesters of the History of Life online paleontology course, we modified the local fossil field investigation into a student-directed analysis of local paleoenvironments based upon local informal learning sites, such as national parks, museums, nature trails, and local university or community displays of fossils. The assignment was further modified in 2009 to include a "Cruising the Local Fossil Freeway," in which teachers reconstructed a paleo-travel guide for their local areas, similar to Johnson and Troll's (2007) exploration adventures in the western US.

Self-directed research moved beyond local fossil investigations to incorporate other topics, and other online courses. In the Geology of North America course, teachers investigated the tectonics of a favorite US national park, as well as the tectonics in their own localities. Duplication of national parks was not allowed, so each teacher contributed different research investigations to the online classroom discussions. Similarly, in the Earthquakes and Volcanoes course, each teacher first selected an active fault—and later in the semester, an active volcano—and researched the topic. Each teacher had to seismically monitor his/her selected fault and volcano through real-time seismic data posted on websites. Each teacher also provided the class with fault zone and volcano updates under a personal web thread.

For the monitored fault system, each teacher designed and constructed timelines. Both a timeline with *geological time* and timeline with *human time* events were required. The fault investigations often included the history of major scientific achievements in fault monitoring, large earthquake events along the fault system, and even local folklore concerning the fault zone.

The history of scientific investigations and advancement, local culture and folklore, and historical eruptions were included in the volcano research projects. Teachers developed concept maps to summarize important aspects of their researched volcanoes, and also designed units for their individual classrooms using volcanoes.

Community of Learners

Local community relationships and interactions. The first 2006 student-directed fossil investigation necessitated contact between the enrolled teachers and local geological experts (for fossil site information and/or identifications) and/or landowners (for access to collect). However, community involvement was heightened when teachers investigated local *informal* educational sites for the History of Life research assignments in 2007 and 2008. The teachers interacted with local museum, fossil park, or university personnel as s/he investigated what type of educational experiences were available at each facility. Teachers arranged to photograph specimens, and reconstructed past paleoenvironments of their local areas based upon the past fossil evidence. (Directions for photographing specimens changed every semester, and included different logos and scales to ensure that the work was done in the semester it was assigned.) In the development of classroom units utilizing these same fossils and facilities, teachers further interacted with local members of their community to plan field excursions for their own students. Although the "communities" of the enrolled teachers were separated by hundreds of miles, the interactions were similar.

Online communities of learners. Not only did practicing teachers acknowledge the importance of building contacts in their local communities (Clary & Wandersee, 2009c), but *online* community-based learning was recognized by our teachers as important for facilitating online science learning. Therefore, based on these early anonymous teacher reflections, we continued and expanded online discussion forums in our online classrooms, and built mandatory online discussion practices into the various online science curriculums.

Little research exists for the use of online discussion boards in totally online classrooms, but parallel research studies have investigated online discussion board use in traditional classroom settings. Kay (2006) investigated online discussion boards as an extension of a traditional classroom environment and found that participation in the discussion boards was significantly positively correlated with students' learning performance. Patel and Adekoya (2006) similarly concluded that with on-campus courses, student participation in online discussions and participation in student-to-student learning had a positive impact on learning.

In each of our online classrooms, several forums are available for online communication. All online courses include a "Student Lounge" for story-swapping and non-course related conversations, while an "In the News" forum provides opportunities for conversations about the current "hot topics" in science. "Student Questions" supplies a forum for conversation directly relating to course assignment or content. Depending upon the classroom, there are specialized forums available for students. All online classes with hands-on specimen kits have specialized discussion threads for these unknowns. Our online teachers can post individual photographs of their unknown fossils, rocks, or minerals in the appropriate discussion forum, and discuss specimen characteristics, such as the hardness, streak, or special properties of an unknown mineral sample. Because natural fossil, mineral, and rock specimens vary in nature, these online forums give teachers an opportunity to compare samples and characteristics even when they have access to a singular set of samples.

When individualized student-directed research is assigned, specialized discussion board threads provide opportunities for the teachers to share their research with the rest of the online class. In the Earthquakes and Volcanoes course, each teacher posted background information about the selected fault, and provided regular updates of seismic activity along the fault zone. The activities were repeated later in the semester for a selected volcano. The result within the online classroom was a series of discussions between the fault zone's researcher, the course instructor, and other enrolled teachers in the course. Photographs of a visit to a selected volcano, developed classroom activities involving a particular earthquake fault, and questions about major eruptions or events were included in the multi-threaded conversations that evolved online (Figure 1). The discussion board conversation is asynchronous, allowing each teacher to review the material and post comments and questions at his/her convenience. Because the online conversation is required as part of a research assignment, it is graded and scored, based upon the content and quality of the introductory material, responses to teachers' or instructor's queries, and regularity of seismic updates.

Active-Learning Strategies

The response to the first pioneer assignment that directed teachers to investigate their local fossil environments was overwhelmingly positive. Teachers noted that the assignment moved them beyond their computers—an element often missing in online classrooms—and forced them to apply the science content material (Clary & Wandersee, 2008a). Therefore, in addition to self-directed, community-based content delivery, we also focused on active learning strategies for delivery of science content.

Hands-on mineral, rock, and fossil specimen kits. An obvious insertion point for active learning in the online classes involved the identification of unknowns: rocks, minerals, and fossils. Whereas some previous instructors utilized photographs and descriptions, we investigated the possibility of providing each online teacher with a customized kit of selected samples and specimens. Rock and mineral kits were provided for each teacher in the Geology I: Processes and Products course, while fossil kits were sent to those teachers enrolled in the Geology II: Earth and Time, and History of Life courses.

Prior to the beginning of the semester, the instructor contacted a geological kit distributor and customized the number of samples and the unknowns for each online course. The supplier mailed a hands-on kit of unknowns to each registered teacher in the class. The teachers received rocks, minerals, and/or fossils that were numbered, but did not have labeled identifications. It was the teachers' assignment to identify the unknowns (from lists of possible options) based on the physical properties and characteristics (Figure 2). For example, teachers were instructed to investigate hardness, streak, magnetic properties, reaction with weak acid, crystal structure, fracture, and cleavage with each of the unknown minerals. Because no two natural samples are identical, discussion boards were developed specifically for the unknowns. Our online teachers posted photographs and properties of problematic unknowns, and sought their colleagues' data on the numbered specimens. A timed examination assessed the properties and the identifications of the unknown specimens at the assignment's conclusion.

Virtual field investigations. Hand samples did not always serve to adequately convey different concepts in our online classrooms, and we could not mandate a common informal excursion to demonstrate, in the field, important scientific principles. Therefore, we investigated whether active learning strategies that utilized virtual field exercises could be implemented successfully as a vehicle for science course content in online classrooms (Clary & Wandersee, in press). In Geology I: Processes and Products, teachers downloaded the free version of Google Earth software. Each quarterly laboratory assignment in the course included Google Earth activities, which were posted as PDF files on the course website. Teachers examined coordinate systems, constructed topographic profiles, and investigated various Earth landforms—including volcanoes, faults, folds, glaciers, seashores, and deserts—within the various virtual field excursions (Figure 3). The Google Earth exercises were assessed, in conjunction with the other assigned activities, as part of a timed homework exercises exam.

Figure 1. Online discussion boards provide opportunities for online student colleagues to communicate and learn from each other. The asynchronous nature of the discussion board allowed teachers to post at their convenience. The recorded conversations were available for review during the semester.

Figure 2. Customized mineral, rock, and/or fossil kits were mailed to each student at the start of the semester's classes. Students were responsible for investigating the different properties of the unknowns, and identifying each sample. Discussion boards provided an online forum where the online teachers could seek their colleagues' opinions about the unknowns.

The history of science and the Great Dinosaur Feud. In History of Life, we injected a research investigation into the history of science, rife with intrigue, deceit, and grandiose investigations. When the class encountered the study of vertebrates, and particularly dinosaurs, a research investigation into the Bone Wars was launched. As part of content implementation within a quarterly laboratory assignment, our practicing teachers investigated the Edward Drinker Cope and Othneil Charles Marsh controversy. Each teacher chose, or was assigned, a Cope or Marsh position. An online discussion thread allowed teachers to share their stance on the controversy, as well as post materials each developed for her/his own classroom.

Local Environment Inclusion

The first student-directed research investigation in 2006 resulted in overwhelmingly positive responses for inclusion of local environments in self-directed, active learning research investigations (Clary & Wandersee, 2008a). The 2007 and 2008 History of Life projects extended local environment investigations with the inclusion of our teachers' local informal educational sites in paleoenvironmental reconstructions (Clary & Wandersee, 2009c). The 2009 History of Life culminating project likewise included the local environment with the construction of a paleo-map for each teacher's local environment. However, it is not always feasible to direct our teachers to local field sites or informal educational facilities for projects throughout the semester. Therefore, we focused our efforts on the inclusion of interdisciplinary science topics that would not only include the science content for the course, but provide our teachers with the opportunities to customize the assignment for their individual classrooms, or their personal "local environments." These interdisciplinary science investigations were incorporated in our online courses as quarterly laboratory homework assignments (History of Life, Earthquakes and Volcanoes, Geology of North America), or as an elective extra-point research investigation (Geology II: Earth and Time).

Marquee Fossils. We first investigated the use of interdisciplinary topics for online science content delivery and curriculum development in the 2007 History of Life course. The Marquee Fossil concept was utilized as a portal through which the enrolled teachers could research an appropriate fossil that would represent their state (or country, in the case of teachers enrolled outside the US). The term "marquee fossil" represents those fossils that have one or more unique characteristics that pique students' interest and invite further integrated science investigation (Clary & Wandersee, 2008b). Teachers were directed to nominate a specific fossil that would serve as a Marquee Fossil for their classroom. The requirements were that 1) the fossil had to be found within the teacher's state, 2) the fossil could be the state's "state fossil" or could be a substitute, 3) the fossil had to be described using a correct taxonomic classification, and 4) the fossil's geographic and geologic range had to be specified. Each teacher defended why s/he had chosen a particular fossil to serve as her/his classroom's Marquee Fossil, and then developed an activity for the classroom using the selected fossil (Figure 4).

Figure 3. Google Earth was used in our online classrooms to transport teachers to a variety of "field locations." The assignments were posted as PDF files, and teachers were directed to investigate various Earth features as part of their quarterly homework laboratory assignments.

Figure 4. In the Marquee Fossil assignment, teachers selected a fossil from their states which would serve as a good geobiological portal for science study. Trilobites were the most often chosen fossils.

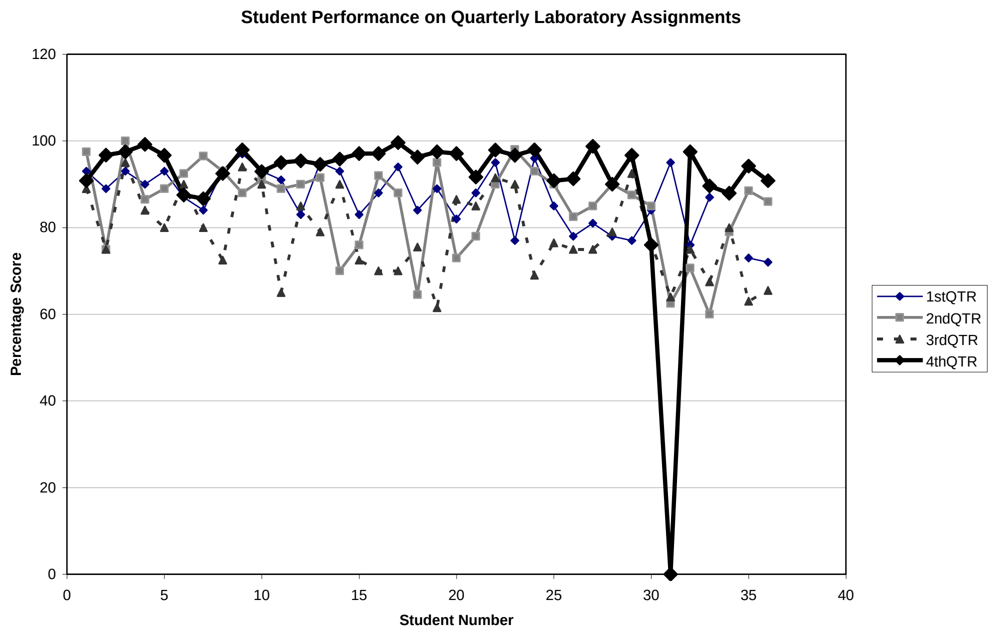

Figure 5. Comparison of the original 2006 History of Life teachers' performance on the quarterly laboratory assignments revealed that our practicing teachers scored higher on the self-directed field activity than the previous assigned laboratory investigations. The self-directed field activity scores are represented in the 4th Quarter assignment. (One teacher did not turn in a 4th quarter project, and earned a zero for the assignment.)

A multitude of interdisciplinary portals. Other generalized portals for interdisciplinary investigation were interjected within online science courses as vehicles for course content delivery. Amber and coprolites were used as an interdisciplinary portal when fossilization processes and taphonomy were discussed in the online classroom (Clary & Wandersee, 2009b), and diatomaceous earth was utilized when microfossils were studied. Stromatolites and a coal "cycle" also provided interdisciplinary portals when prokaryotes were part of the curriculum, or plants, cyclothems, or paleoenvironments were investigated, respectively. Although each assignment was customized for each online classroom, most interdisciplinary investigations involved two distinct assignment components: Teachers had to research in more depth the particular scientific concept embodied by the topic, and develop activities and/or mini-units for their individual classrooms.

Data and Results

Student-Directed Research

The pioneering self-directed research investigation in History of Life allowed us to directly compare teachers' performance on the self-directed research investigation with their performances on three other quarterly laboratory assessments. Approximately 86% of students

(N = 36) scored higher on the self-directed, field-based investigation (Figure 5). Not only did quantitative analysis reveal significance for the informal research investigation at the 95% confidence level, but content analysis of teachers' responses (Neuendorf, 2002) indicated that most teachers did not encounter any more difficulty than students in traditional classroom environments when planning and carrying out research investigations (Clary & Wandersee, 2008a). Teachers further noted that the multidimensional aspects of the assignment, the active learning experiences, and the ability to use and adapt their research for their own students were positive attributes of self-directed research assignments in online science classrooms. The method was also noted as being effective for delivery of science content: Our teachers reported that the application component of the assignment was more beneficial for science content learning when compared to the more traditional approaches and assignments.

Based on the success of this first 2006 assignment, we incorporated more self-directed, active learning, local environmental investigations in our online classrooms, and all quarterly laboratory assignments in subsequent semesters involved self-directed, active learning, and/or local environments. Therefore, we were not surprised when a comparison of quarterly laboratory assessments did not reveal any significance in teachers' scores between the earlier three laboratory assignments and the final laboratory assignment of the self-directed fossil investigation via local informal educational sites (Figure 6). From qualitative analyses of the 2007 and 2008 teachers' responses (N = 28), several stable findings emerged. Teachers noted that the self-directed fossil research using local informal educational sites affirmed the importance of their local environments and helped them to place this environment within a larger context, and that the use of informal educational sites provided context for the science content in the course and supplied an interdisciplinary "big picture" (Clary & Wandersee, 2009c).

The Common Ground of the Local Environment

Although our science courses are taught online, teachers consistently remarked that there was great value in the use of their local, individualized environments for successful science content delivery. With the Marquee Fossil project, 38% of the teachers self-identified that the connection of the fossil to the *local* area and the subsequent environmental changes was of greatest value (Clary & Wandersee, 2008b). The local environment could be translated also into the teachers' individual classrooms: Local fossils and informal field sites were familiar and of interest to our teachers' students, and would hook them into a deeper study of science (Clary & Wandersee, 2008b). Likewise, a teacher reported that when she shared her paleoenvironmental research with her own students, the students were most interested that the teacher "recreated OUR area, not some unknown area far away" (Clary & Wandersee, 2009c). The local environment investigations also strengthened teachers' connections with their local communities, and facilitated a familiarity with local resources (Clary & Wandersee, 2009c).

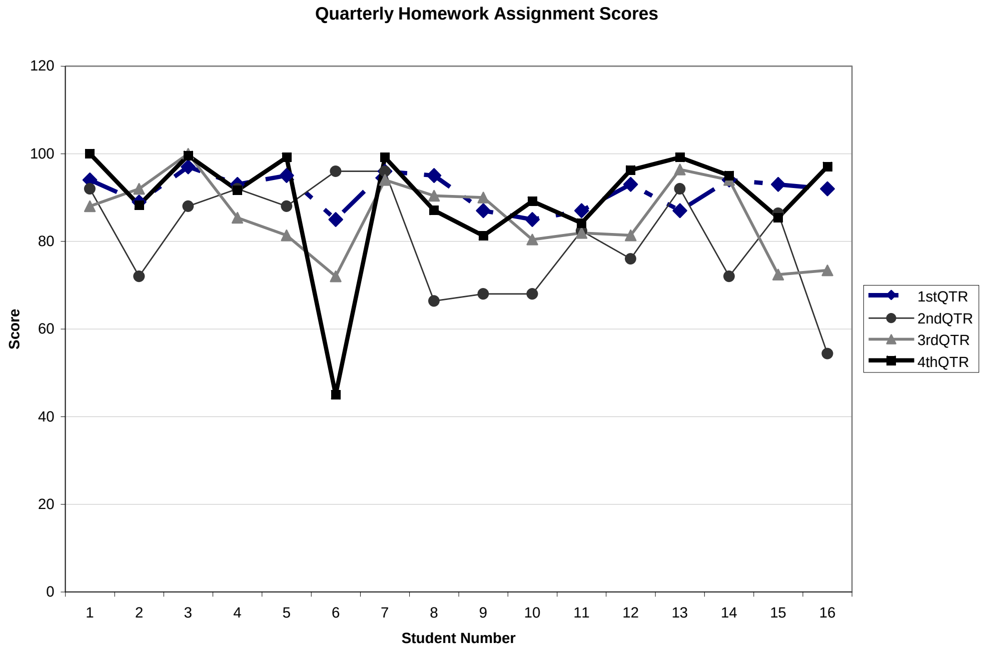

Figure 6. Comparison of the 2007 History of Life teachers' performances on the quarterly laboratory assignments did not reveal any significance for the last (4^{th} QTR), local informal educational investigation of fossils. However, all the quarterly laboratory assignments that semester involved self-directed research, active learning, and/or local environments.

Community of Learners

Content analysis revealed that teachers in our online classrooms believed that local community interactions were important for their own classrooms, and for building science learning upon their previous knowledge and experiences. However, in addition to being interested in investigating their communities and forging professional relationships locally, teachers enrolled in our online classes reported that chat rooms and online discussion boards facilitated the development of their *online community* of learners (Clary & Wandersee, 2009a). Through the use of the discussion boards and participation in several cyber-conversations, the teachers were active and contributing members to the online science courses. Unlike traditional classroom discussions, the asynchronous nature of the conversations allowed for teacher reflection. Conversation threads were archived on the online discussion board website for future readings, reflection, and responses for the duration of the online course. Therefore, the online discussion boards comprised an indirect review of course material, or—as in the case of independent tectonic site investigations and selected fault zones and volcanoes—an extension and application of the courses' science content.

Interaction analysis of discussion board conversations also revealed that teachers were reading diverse sources and posting throughout the semester for their individual research projects' discussion threads. Because discussion board participation was required with some of these self-directed research projects (i.e., Earthquakes and Volcanoes, Geology of North

America), the teachers had to marshal evidence and data, and logically present their findings to their online colleagues. Therefore, our online community was participating in authentic scientific conversations by using correct scientific terminology, and exhibiting scientific behavior in their communication skills.

Some of our practicing teachers stated that the hands-on fossil, rock, and mineral kits were their favorite aspects of the online classrooms (Clary & Wandersee, 2009a). Because all the registered teachers faced the same daunting task of sample identification, the teachers formed an online discussion community and assisted—and taught—each other in their investigations.

Active Learning Strategies

The hands-on sample kits provided teachers with a glimpse of the nature of science in the online classrooms by providing trial-and-error investigations of unknown specimens. Other active learning research investigations, such as the Dinosaur Feud, proved to be successful additions to the online science environment as vehicles for content delivery. Teachers remarked that the history of science, even when presented as "scientists behaving badly," was important in the classroom. It conveyed to students the human side of scientific endeavors, and underscored the importance of research integrity (Clary et al, 2008). History of science also validated the processes by which the body of science grows: Even though mistakes are made by participants in the research process, further research will ultimately correct the errors. Our online teachers reported that this history resulted in greater interest and better understanding of the nature of science (Clary et al, 2008).

Incorporation of the virtual field exercises also was an asset to the online science curriculum for many teachers. When we analyzed the performance of Google Earth test items against other test items for the quarterly laboratory examinations, no significance was revealed ($\rho = 0.05$). Although anonymous survey responses revealed a bimodal distribution of teacher opinions for Google Earth in the online classroom, the responses were still largely positive (73%) (Clary & Wandersee, in press). Most teachers enjoyed the use of modern technology in online science classes, and recognized several applications of mapping software in their own classrooms. Our implementation of virtual field investigations seemed a good compromise to "field excursions" in the online classroom, where onsite field investigation in a common location is practically impossible.

The use of interdisciplinary topics for research investigation tended to score positive marks in the anonymous survey responses at the end of the semester. These interdisciplinary portals adhere to the "less is more" strategy advocated by the theory of human constructivism for meaningful science learning. By using interdisciplinary topics in our classrooms, teachers were able to determine the direction of their research, and personalize applications of their research for their individual classrooms. This ensured that teachers could direct their research and develop activities for their individual classrooms which they could directly use. Our teachers reported that amber, coprolites, stromatolites, coal, dinosaurs, and some microfossils were inherently interesting, and had application within their own K-12 classrooms (Clary & Wandersee, 2009b). Conversely, exercises from laboratory manuals that directed learner outcomes, as well as assigned research topics with a narrow focus, were not well received in our online classrooms.

DISCUSSION AND CONCLUSIONS

Unstructured interviews (Summer 2008, Spring 2009 semesters) with teachers who are graduates of the online Teachers in the Geosciences master's program attested to the importance of self-directed research activities, use of local environments, community learning, active learning and inquiry-based methods, and the history of science for science content delivery in our online classrooms. Although not all teachers rank the importance of these content delivery vehicles in the same order, the methods consistently were noted by graduates of the master's program who had completed one or more of our courses in their program of study.

Through numerous semesters (N = 10) and a variety of online science courses (N = 6), our research demonstrated that online science curriculum development proceeds successfully through incorporation of what we term "**SCALE**." The online science curriculum should focus upon **S**elf-directed autonomous student activities, **C**ommunity-based learning, both within an online environment and within the students' local area, **A**ctive learning strategies that move students beyond the confines of the computer environment, and **L**ocal **E**nvironment incorporation for easy student access and relevance to individual online learners. The **SCALE** method allows for interdisciplinary and integrated science curriculum in a variety of online science environments. Practicing teachers direct and customize their research within their local communities and for their own classrooms. The resultant curriculum is consistent with the theory of human constructivism, which emphasizes meaning over memorization, quality over quantity, and understanding over awareness for a "less is more" strategy. Although content is individualized by each teacher, scientific habits of mind and the nature of science are revealed within the online classroom through the **SCALE**-developed curriculum.

Our research further reveals that **SCALE** can be accomplished through autonomous informal education activities utilizing local field sites, museums, and nature parks; investigations into the history of science which shaped the discipline and current understanding; community discussions, both within the online discussion board format and the development of local contacts within a student's geographic area; and incorporation of interesting topics (i.e., amber, stromatolites) as portals for self-directed interdisciplinary research and classroom implementation. Our mixed methodology research investigations indicate that more successful learning occurs within an online science **SCALE** curriculum. Content analyses of survey responses over several semesters concluded that teachers can *learn* in an online science environment (Clary & Wandersee, 2009a). Past graduates of the Teachers in Geosciences Program also indicated that the **SCALE** curriculum may result in more positive student attitudes toward online science courses, but more research is needed in this area to elucidate quantitative and affective learning outcomes.

As more and more science teachers turn to the online environment for professional development, science educators must implement methods and content within online science course curriculum that not only maximize science content learning, but are relevant to individual teachers. We propose that the **SCALE** model for online science curriculum development can accomplish this. We hypothesize that **SCALE** can result in positive learner outcomes for online science courses composed of non-teachers as well. However, more research is needed before implementation of the **SCALE** curriculum within an undergraduate, online science course.

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Chapter 13

REVISING THE ARCHAEOLOGY CURRICULUM TO MEET THE DEMANDS OF THE 21ST CENTURY

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INTRODUCTION

While the social, political, and employment contexts of practicing archaeology have changed over the past 30 or so years, curriculum structure and content and post graduate opportunities have remained relatively unaltered well into the 1990s. One reason for this is the development of archaeology as an academic, university taught discipline. For over 100 years, archaeology has been a formal academic discipline taught as one of the four classic sub-disciplines of anthropology, and the traditional professional outlet for most archaeologists has been the academy (Michaels 1996:192). However, given how archaeology is currently practiced it has, by necessity, expanded beyond the academy.

Archaeology has changed significantly, not only in method and theory, but with respect to its obligation to help manage cultural heritage in the public interest. As a result, professionals have had to rethink how students are educated and trained in order to meet the new challenges of a century in which the majority of archaeologists are employed outside the academy in governmental and private sector settings (Smith et al.1995; Zeder 1997). It is also clear that students must have both an academic and a pragmatic understanding that heritage resources are nonrenewable and finite and must have complete and substantial documentation; that archaeologists do not have an exclusive right to the interpretation of the past; and that many people besides archaeologists have a vested interest in the past and its material remains.

The need for public support for archaeology demands that students must also be able to demonstrate the discipline's relevance in contemporary society, especially within the contexts of professional ethics and values and competing national and international agendas. Especially in a strained economy, the use of scarce resources must be carefully designed and justified. Students must be able to effectively communicate both within the profession and with the public through written and oral media and to apply archaeological method and theory to issues and problems, some of which might be influenced by factors outside the heritage arena. To deal with the changing demands of the profession two initiatives were undertaken by the Society for American Archaeology (SAA) – Teaching Archaeology in the 21st Century and Making Archaeology Relevant in the 21st Century (MATRIX).

Both the Teaching Archaeology in the 21st Century and MATRIX initiatives grew out of earlier activities undertaken by the SAA. The first was the 1989 "Save the Past for the Future" working conference followed by the second "Save the Past for the Future" working conference in 1994 in which recommendations regarding formal education and professional development were pursued.

Participants in the Teaching Archaeology in the 21st Century initiative made recommendations on how those needs outlined above could be addressed by the undergraduate and graduate curriculum. Central to their mission was the notion that one of the most potent means for combating rapid destruction of the archaeological record was the education of diverse publics about the value and significance of knowledge that could be produced through archaeological inquiry (McManamon 1991). Over time this perspective has expanded to include the idea that public engagement in both research and interpretation is also essential to preservation. From the outset, the students that archaeologists teach formally were considered a key component of this audience.

TEACHING ARCHAEOLOGY IN THE 21ST CENTURY

In its contribution to the final report on the Society for American Archaeology's "Save the Past for the Future II" working conference, the Professional Involvement Work Group captured standard practice for this time period by envisioning an alternative professional profile.

> In an ideal world, professional resumes would routinely include evidence of public education work, while archaeology curricula would reinforce the value of public education. At the graduate level, a public archaeology course would become a consistent feature of degree requirements, and undergraduate courses would include public archaeology issues and training as a recurrent theme. Sustained public education activity among archaeologists would also be used to address multi-cultural issues, helping to build strong ties with Native American communities. Finally, archaeology education activities would become the vehicle for creating partnerships with disciplines having allied interests, such as museum studies and public history.
>
> In short, the ideal world would be one in which public education would be a valued and accepted component of archaeologists' professional lives, and adherence to this standard would promote public awareness of numerous issues vital to the discipline, including cultural resource preservation, continued public and governmental support for archaeology, and validation of post-secondary archaeology curricula (Smith et al. 1995).

Yet even as these words were being penned, the contexts within which archaeology was practiced were being dramatically altered, and post-processual theorizing was urging archaeologists to think of their work as a profoundly social undertaking. These changes have framed and propelled responses in the discipline to the extent that the profile imagined above now seems far more real than ideal.

The 1998 workshop on Teaching Archaeology in the 21st Century was designed to initiate the curricular reform urged in 1994. Its purpose was to support a productive dialogue that would define central issues and provide content guidance for fellow academicians who might be interested in changing what and how they teach but had little experience with the more applied dimensions of the discipline. Thirty-five archaeologists representing a wide range of professional contexts were invited to attend, and many prepared position papers to help spur the discussion (Bender and Smith 2000).

Several papers characterized the status quo for archaeology education in colleges and universities at the turn of the twenty-first century (McGimsey and Davis 2002, Krass 2002, Smith and Krass 2002). They noted the persistence of a traditional liberal arts pedagogy that promoted strong emphasis on student acquisition of fact and theory with little explicit reference to broader applications of knowledge and skills. In support of this interpretation, Smith and Krass documented in a survey of 117 graduate and undergraduate programs that 61% did not include public archaeology components because "other courses take priority" (2002: 23). All authors agreed that "the traditions of academic training have not kept pace with changing contexts for the practice of archaeology" (Bender 2002a: 3).

There was ready agreement among the conference participants that the contexts for the practice of archaeology had changed dramatically and that they needed to identify those changes before they could begin the task of redesigning archaeology curricula to respond to them. After vigorous discussion, the following factors (both internal and external to the discipline) were defined, but not prioritized:

A growth of the market in antiquities accompanied by unprecedented site destruction
Threats to our archaeological heritage by construction and development activities
The implementation of cultural resource legislation and subsequent growth of the cultural resource management profession
The passage of legislation regulating treatment and access to human burials and artifact collections
Heightened popular interest in archaeology, including the growing interest of descendant communities in their archaeological pasts
The equal effects of these factors on prehistoric and historic archaeology such that distinctions between the two have become blurred (Bender 2002b: 32)

The task that then confronted conference participants was to conceptualize the educational requirements of this changed context. What new principles must structure archaeological curricula? What new skills should students develop in the course of their training? How can these principles and skills be effectively articulated with a traditional liberal arts education? These were the central concerns that guided subsequent discussions, and in those exchanges it became apparent that the SAA's Principles of Archaeological Ethics (Lynott and Wylie 1995) both captured the ethical implications of archaeology's changed context and delineated the skills required of archaeologists seeking to implement a renewed, ethics centered archaeology. Based on these considerations, the following "Principles for Curricular Reform" were articulated.

Stewardship. An archaeology curriculum should foster stewardship by teaching students that archaeological resources are nonrenewable and finite and must have complete and substantial documentation.

Diverse Pasts. An archaeology curriculum should make students aware that archaeologists no longer have exclusive rights to the interpretation of archaeological resources, but that various publics have stakes in the past.

Social Relevance. We must effectively articulate the ways in which we can use the past think productively about the present and the future.

Ethics and values. The linkage of the seven SAA Principles of Archaeological Ethics to specific points within the curriculum will provide students with a basic foundation for cultural resources, as well as promote a traditional goal of liberal education: clarification of values.

Written and oral communication. To be able to communicate their goals, results and recommendations to diverse audiences, archaeology students must be taught how to think critically, write effectively, and speak clearly—all of which are central aims of a liberal arts education.

Fundamental Archaeological Skills. Students planning a career in archaeology must master a set of basic cognitive and methodological skills.

Real World Problem Solving. Students must learn how to apply basic knowledge and skills in the solution of a fully contextualized archaeological problem.

Stewardship

The first principle of archaeological ethics is Stewardship which therefore becames the first core principle for teaching archaeology. According to the SAA Taskforce recommendations, college and university courses should always emphasize the non-renewable nature of the archaeological record. As part of this discussion, the damage caused by looting sites and trafficking artifacts should be presented in the context of the loss of information and ability to interpret the data.

Once students understand the value of the resources, and their fragile nature, they need to examine methods of stewardship which can include stabilizing an archaeological site, preserving it in place, excavation, or promoting public understanding of the information content of the resources through site development and interpretation. In some cases the principle of stewardship may require archaeologists to place preservation above their research interests.

In recent years, the concept of stewardship has become controversial. Originally, the principle was intended to encompass as wide an audience as possible, since the drafters of the code of ethics believed that no matter what people believe about who owns the past (or a particular material signature of the past) they usually agree that it should be protected and preserved (Alison Wylie, p.c.). The problem arises from the fact that deciding who will be the stewards of a site, what exactly is to be preserved, and how stewardship is defined can cause conflict. Often archaeologists find that several different groups have a legitimate claim to stewardship of some cultural resource. These claimants may include local people, descendant communities, several scientists with competing research agendas, government agencies also with competing agendas, museums, tourist agencies, etc. Thwarting the interests of any of these groups can result in neglect, political turmoil, outright site destruction, and even violence.

The interests of people who want new roads may conflict with those who want to preserve large areas of landscape as part of archaeological heritage parks. Sometimes people wish to continue to use monuments even though the use may damage them and require frequent maintenance of the preserved features; in these cases it is often the case that the users of a monument are concerned with preserving their intangible culture, which references the material record of the past through active engagement. From this perspective, preservation of a monument by disallowing use is preserving nothing; such enforced stasis in the presentation and use of the past is outside normal cultural practice, since living cultures adapt and change perpetually today as in the past. Authorizing only a single past from a single slice of time may be seen as essentializing; stereotypes can be useful or oppressive depending on how they arise and how they are used in the present.

Diverse interests

Second, the SAA taskforce recommended that students learn that many people are interested in the past. In presenting archaeology courses to undergraduate students, the instructor should make students aware that archaeologists cannot claim exclusive rights to the past, but that various publics also have a stake in the past. No one truly "owns" the past; rather, we all share common roots in that past which bear different fruits. Diverse groups such as descendant communities; state, local, and federal agencies; artifact collectors, tour guides, tourists and many others compete for and have vested interests in the non-renewable resources of the past. Students also need to understand preservation laws so that they may gain an understanding of the importance archaeology places on the protection of our common human heritage. They should also be made aware that relationships can be enhanced through the development of partnerships with these diverse groups. By examining the ways that the products of the past have been used to further political and national interests, students can also be made aware of the social implications of our discipline.

When the Native American Graves Protection Act (1990) legalized the rights of Indigenous Americans to reclaim the material remains of their ancestors from American museums and laboratories, many archaeologists believed that their research was doomed. Instead, many have found the necessity of working with Native Americans has resulted in a new type of collegiality that has increased scholarly knowledge of contemporary Indigenous issues and enhanced our understanding of the past.

Social Relevance

In a world of food shortages and natural disasters, if we are to justify archaeology's existence as a discipline—in terms of both public support and public interest—we must effectively articulate the ways in which it benefits contemporary society. In the past, archaeologists considered these benefits to be self-evident. Teachers simply presented the "substance" of our field and assumed that students would intuitively see its value. This complacent view can no longer govern the way archaeology is taught. Given the existence of diverse interests in the past, those who teach archaeology in the twenty-first century must convey why *we* believe that archaeology is important. One way to convey archaeology's relevance to today's students is to highlight ways in which we can use the past to help us think productively about the present and the future. Many examples of this type of interpretation are now available in the literature on American Archaeology. In the past, archaeologists mostly expected study of the past to produce cautionary tales for the present. Environmental misuse, overpopulation, war and violence were investigated under the rubric of not wanting to be condemned to repeat past mistakes. More recently, research on the past undertaken with a less deterministic attitude has been more successful in discovering past achievements that may expand our knowledge of what is humanly possible and even open up new possibilities for the future. Studies of long-term sustainable subsistence practices, such as raised fields and the development of "dark earth;" studies of social patterns that suggest ancient strategies of gender equity; and investigation that elaborates on the long term role of material culture in the negotiation of a positive national identity are just a few examples of this type of research.

Professional Ethics and Values

Articulations of ethics and values are a sign of the growth and maturation of the profession of archaeology. The seven SAA Principles of Archaeological Ethics are fundamental to how archaeologists conduct themselves in relation to the resources, their data, their colleagues, and the public. Linking these principles to specific lecture topics provides students with a basic foundation for establishing their interest in the study of cultural resources. Students must be brought to the understanding that ethical practice is not something added to scientific and scholarly endeavour, but is fundamental to the inception of all such effort in archaeology as in any other field.

Communication

Although most countries have strict laws about how archaeological resources must be treated, it is never possible to enforce such regulations through constant oversight; there are simply too many archaeological sites (Smith et al. 2010). Consequently, archaeology depends on the understanding and support of the public so that they will not engage in looting and site destruction as soon as the archaeologists and government representatives leave the area. To develop a concerned audience and a sympathetic public, archaeologists must communicate their goals, results, and recommendations clearly and effectively.

Within the discipline itself, the principle of communication refers to the fact that archaeology education needs to incorporate frequent training and practice in logical thinking as well as written and oral presentation. For any non-specialist audience, jargon inhibits understanding and makes it less likely that archaeological goals will be understood and supported. An archaeologist must be able to make a clear and convincing argument in public as well as in professional contexts based on the analysis and interpretation of relevant information. All too often scholarly effort cloaked in overly complex language conceals errors of logic and interpretation that are not even obvious to the writer. For this reason, insistence that students master the ability to explain their work in plain language is salutary for them as well as their audience. Effective communication also includes mastery of standard tools like computers and the Internet, as well as the ability to interact cooperatively and effectively with others involved in producing a product or reaching a decision.

As scientists whose efforts are intended to contribute to a growing storehouse of information that will be available to future generations, archaeologists are also required to publish reports and analyses of their data couched in appropriately theoretical terms. Consequently communication also includes scholarly communication among researchers of sufficient quality to retain its value for future researchers. In the final analysis, unpublished data are the equivalent of looted data, meaning that they are not data at all.

Basic Archaeological Skills

Students planning a career in archaeology need to have mastered a set of basic skills. At a conceptual level, these involve the ability to make pertinent observations of the archaeological record, to record and describe these observations, and to make appropriate inferences. Skills include basic principles of surveying and cartography (e.g., map-making and reading), stratigraphy (e.g., ability to draw accurately and interpret a soil profile and use a Harris Matrix), archaeological methods (e.g., ability to complete field and laboratory forms), database management (e.g., ability to create and use data tables), and technical writing (e.g., ability to write artifact, feature, and site descriptions).

Although the use of sophisticated technologies is desirable, students are more in need of an understanding of what these technologies can do and the circumstances that warrant their use than training in the use of specific equipment. In reality, there are too many types of mapping and excavating aids to make too much of this specialized training worthwhile. Acquisition of the skills for using specific applications will need to come from specific jobs. In the classroom students need to learn how to decide which technologies suit which research contexts, what strategies can be employed when optimal tools are not available and how to determine the relative costs of various daily compromises. This can be as simple as a choice between using a trowel and using a shovel, the decision must be made by someone who can evaluate to cost of choosing to save time over choosing to save subtle stratigraphy.

Real-World Problem Solving

One of the most difficult things for undergraduates to do is to connect the classroom world and the real world. Helping students make this transition in the context of course work often drives home the main points and demonstrates an applicability to their lives and professions. The essence of "real-world problem solving" is flexibility and grounding in the basics of archaeology. Students can be exposed to problem solving through classroom examples and observations of real situations. An important aspect of reality is communicating that archaeology is one of many interests that must be reconciled for projects to be completed successfully.

Explaining the social, cultural, political and economic context of contemporary archaeology is a crucial aspect of teaching at the college level. Having students attend a session or meeting of a descendant population where archaeology is discussed will be an eye-opener. It is our public service responsibility as professors of archaeology to demonstrate through examples and assignments a basic understanding of how business, politics, and local communities or bureaucracies work, as well as to foster an understanding of preservation laws and regulations. Archaeology outside the academy is usually done when it is part of a solution to a problem in construction and development, a disputed location of something, or planning to avoid a problem in the future. One way to expose students to this process is to have them attend a routine local city or county commission meeting or have politicians lecture to the class about the political process.

During the 1998 conference, consensus emerged rather easily around changed contexts and the attendant principles for curricular reform, but it was clear that there were differences in perspective regarding the target audiences. For some conference participants, the key issue was how to train our students more appropriately for the range of career opportunities that await them after graduation; others conceptualized the educational task more broadly and were concerned with teaching all our students about the applied dimensions of archaeology and the effects of its public context on knowledge production. These differing concerns essentially depended on whether participants were viewing curricular reform through the lens of undergraduate or graduate education.

Those primarily concerned with undergraduate education thought about reform through the perspective of the diverse range of student interest that they encounter in their classes. Many students take just one or two classes in archaeology, while others are clearly headed for a professional career. What principles should students engage if they have just a passing interest in the discipline, and what must an aspiring young professional learn? To answer this question, participants sought to identify how each goal might fit into existing course structures rather than recommending the creation of new, stand alone courses. To reform the curriculum for all our students would mean infusing the standard curriculum with knowledge content and skill building exercises at all levels. The task was simplified for this work group because of a standard structure for the undergraduate curriculum, and they were thus able to match typical courses and their target audience with appropriate principles (Bender 2002b: 37-38). In addition, the work group identified a set of topics that might be used to engage student interest in each of the principles.

In accomplishing this work, the Teaching Archaeology in the 21st Century initiative implemented a major recommendation emanating from the 1994 workshop, "…to encourage the inclusion of an applied curriculum at the graduate and undergraduate levels" (Smith 1995 et al.: 39). What still remained was the task of compiling "sample syllabi and examples of internship or directed study projects … for distribution to departments". This is the task assumed by the MATRIX. initiative.

MATRIX: MAKING ARCHAEOLOGY TEACHING RELEVANT IN THE 21ST CENTURY

To initiate the MATRIX work, the Society for American Archaeology sent a questionnaire to the members of the society investigating their needs. Many responded by asking for help in designing new courses and learning to teach new skills. To answer these needs, the authors requested support from the US National Science Foundation to design courses that could be posted on the Internet for use by anyone. Half a million dollars were granted to the MATRIX Project and 30 professional archaeologists from small colleges, large universities, government departments, private contract firms, and museums around the US were invited to collaborate on the project. Participants were selected based on their professional stature, including former presidents of the Society for American Archaeology and the American Anthropological Association, several full professors from outstanding institutions, junior professors with outstanding teaching credentials, directors of large government programs and museums, and owners of multimillion dollar contract firms.

MATRIX participants designed, peer reviewed and test taught sixteen courses over a period of four years, all of which incorporated the seven principles of the initiative. Initially, participants decided that the curricular requirements that were distilled into the Seven Principles discussed in the previous section should be part of all courses at the undergraduate level. Additional information on these principles can be found in the SAA publication *Teaching Archaeology in the Twenty-First Century* (Bender and Smith 2000); in *SAA Bulletins* 16(5), 17(1), and 17(2) (SAA 1998, 1999a, 1999b); and on the SAA website entitled Teaching Archaeology in the 21st Century: Promoting a National Dialogue. These principles are separable, but do not necessarily constitute the basis for individual courses; rather, they are meant to be integrated with more standard goals of archaeological knowledge and practice. The four-year project was also designed to stimulate new teaching and learning models for college courses in archaeology and archaeology-related topics.

The MATRIX project recommended that the principles be infused into the United States National Archaeology Curriculum (which could potentially reach some 30,000 undergraduate anthropology majors and some 500,000-600,000 students taking anthropology courses as electives) with the following approaches:

Design a set of courses based around the Seven Principles identified by the SAA Task Force on Curriculum that use innovative materials and effective teaching and learning strategies.

Design and evaluate these courses in collaboration with a varied set of professional archaeologists, pedagogical experts, and students.

Design courses that will appeal to a larger audience by incorporating technological advances in teaching and learning through web design and the Internet.

Design courses that include multi- and interdisciplinary materials and are applicable to a wide variety of two- and four-year institutions.

Design courses that target students who may not be pursing careers in archaeology (the vast majority), while at the same time providing the basis for those students pursuing undergraduate degrees (Associate and Baccalaureate) and preparing those who pursue graduate degrees (Masters and Doctorate) in the discipline.

Design courses that broaden participation of underrepresented groups and take into consideration diverse backgrounds and career aspirations, including students preparing to teach grades K-12, minorities, women, disabled students, part-time students, and students who may be changing careers.

Design courses that acknowledge that most professional archaeologists work in the governmental and private sectors, and attempt to bridge the widening gap between research and the discipline as practiced in all its diverse applications.

Produce, promote, and distribute resulting course designs, syllabi, and teaching materials to a wide national audience utilizing print and electronic media and professional meetings and journals.

An Advisory Board consisting of Subject Specialists was assembled for the program. Six Advisory Board/Subject Specialists were selected from academic institutions and four from the federal/state/private sectors. Three professional pedagogical experts/course evaluators assisted with course development and evaluation. Several students were selected to participate in the overall program.

Eight institutions then participated in the three-year Pilot Program by preparing and offering two separate courses. Advisory Board/Subject evaluators, who were archaeologists knowledgeable in one or more of the principles, were available to assist with course development and evaluation. Input from students was also included. The courses were created with the assistance of pedagogical specialists who shifted the focus from professors' typical concern for their teaching to a consideration of what students are actually learning. Three workshops were held to assist facilitate course development and evaluation. An organizational meeting was held to provide project direction, and a final evaluation was held to assess the entire project and the courses developed.

Each participant or participating institution developed and taught two separate courses. The first set was taught in spring 2002, and the second in spring 2003. Guidelines for course development and evaluation were developed at the first workshop. Each course received professional review, before development and after it was taught, by course and subject evaluators (archaeologists knowledgeable in topics covered by the principles). Courses were designed to appeal to a large and diverse audience through the use of technological advances in teaching and learning and covered archaeology as practiced in all its diverse applications. Courses also were guided by the NSF Guidelines for Educational Materials Development.

Participants selected which undergraduate courses they wished to for the MATRIX website. Some developed new courses and others modified existing courses by selecting topics and preparing lectures that encourage student participation and take the following concerns into consideration:

Courses will select topics, prepare lectures, and encourage student participation that take the following concerns into consideration:

Connecting to and preparing teachers K-12
Preparing students for the technological workplace
Preparing students as citizen and stewards
Including underrepresented minorities and women
Including nontraditional students (part-time, changing careers)
Linking two- and four-year institutions
Linking undergraduate and graduate education
Linking education and the workplace
Employing creative teaching and pedagogical scholarship
Developing new materials and practices for a national audience
Addressing the needs of the discipline
Improving learning
Addressing diverse student backgrounds and career aspirations
Considering national needs and opportunities
Using innovative materials
Considering the national distribution of results
Employing significantly new educational materials and pedagogical practices
Using and developing materials that incorporate effective teaching and learning strategies
Employing credible and diverse evaluation
Preparing other faculty at test sites to use prepared materials
Preparing materials for dissemination to other institutions and taking into consideration the need for adaptability and commercial or self-sustaining national distribution
Providing a description of plan to achieve proposal goals
Preparing intellectually vigorous lectures
Employing innovative educational strategies
Developing appropriate course content
Employing sound evaluation
Clearly identifying course objectives and expected outcomes and how objectives will be accomplished
Collaborating with other institutions

Each participant produced a course plan, course description, course syllabi, lecture outline or notes, bibliography, and a complete copy of course materials for each of the courses developed in a format compatible with print and electronic distribution:

Archaeological Field Methods Bill Andrefsky & Bill Lipe, Washington State University
The Archaeology of Ethnicity in America Elizabeth Brumfiel, Northwestern University
Archaeological Ethics and Law, Ricardo Elia, Boston University
Archaeological Methods, Theory, and Practice, Frances Hayashida, Penn State University
Museum Methods Elizabeth Kryder-Reid, Indiana University-Purdue University, Indianapolis
Buried Cities and Lost Tribes: New World, Shereen Lerner, Mesa Community College
North America, Skip Messenger, Hamline University
Introduction to Archaeology, Nancy White, University of South Florida
South America, Nancy White, University of South Florida

Landscape Archaeology, Elizabeth Kryder-Reid, Indiana y-Purdue University, Indianapolis
Mesoamerican Archaeology, Elizabeth Brumfiel, Northwestern University
Time and Culture in the Northwest, Mary Collins, Washington State University
Archaeological GIS ,Dean Snow, Pennsylvania State University
Principles of Archaeology, Shereen Lerner, Mesa Community College
Cultural Resources Archaeology, Ricardo Elia, Boston University
Forensic Anthropology, Susan Myster, Hamline University

These completed courses were then posted to the website in their entirety. The website now has additional information and articles, as well as a Bulletin Board containing comments on this topic. It can be accessed at http://www.indiana.edu/~arch/saa/matrix. The website has been well received and has been used by as many as 30,000 people per month from around the world. Each course contains complete texts of lectures and assignments as well as statements by the designers about their teaching goals; all course materials are searchable so that users can assemble teaching materials together from several courses. Although intended to support university professors, the materials can be used directly by advanced students, or simplified by instructors for use in secondary schools.

In spite of its success, the MATRIX project lacks an adequate international scope. The next challenge for MATRIX will be broadening its value by incorporating courses designed by professionals from many nations. At present, a course on Central Asian Archaeology is under development, and renovation of the original site with a greatly expanded inventory is planned for the near future.

CONCLUSION

Based on the various efforts to examine archaeology and prepare ourselves and our students for the 21st century, we are at a point where we must collectively decide where the profession is heading and chart that course into the new millennium and beyond. The issues discussed here may appear to concern only those who practice archaeology in an academic setting, but nothing could be farther from the truth. The public financing of all but a very minute segment of archaeology, and our responsibilities to the archaeological resource base and the public demands the dedication and participation of those preparing for careers in archaeology as well as its current and future practitioners.

Some 20 years after the Teaching Archaeology in the 21st century initiative, the concept of professional involvement task seems less visionary than imperative. Research proposals now routinely include public outreach components, archaeologists write about their projects' public education initiatives in highly visible outlets (e.g.; *Public Archaeology, Archaeologies: Journal of the World Archaelogical Congress, Journal of Heritage Studies)*, and introductory archaeology textbooks regularly incorporate sections about archaeology's various public faces (e.g. *Archaeology Matters* by Jeremy Sabloff). But what is commonplace now represents a sea change from standard practice in the early 1990s when a generation of archaeologists, who had trained under the processual paradigm, conceptualized their scientific research programs as operating in a socially decontextualized field setting. They were encouraged to think of the field as their "research lab" and thus focused field activities on data retrieval, ignoring the diverse set of communities with competing claims on the archaeological record. At that time, the destruction of their research database seemed a distant prospect.

Today the destruction of the archaeological record through vandalism, looting, collateral damage and ignorance has reached nightmarish proportions. At the same time, archaeologists have realized that not only are they not the sole arbiters of the past, but they no longer want to bear the immense responsibility. The responsibility is too great. Under these conditions the principles of education training and engagement devised by the Teaching Archaeology in the 21st Century taskforce and implemented in the MATRIX course designs resonate through the professions continuing development and the MATRIX website continues to be a source of information and ideas for the present generation of archaeologists.

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Chapter 14

CURRICULUM AND TRANSNATIONAL STUDENT SPACES: DISCOURSES OF IDENTITY AND REPRESENTATION AMONGST CHINESE TRANSNATIONAL STUDENTS IN AUSTRALIA

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ABSTRACT

The paper examines the implications of critical ethnography for curriculum in studies on transnationalism and the internationalization of higher education. It suggests that as universities in Australia are being integrated into the new global system of transnationalism in higher education, particularly with students from the Asian sub-continent, there is a need for re-strategizing in universities in the areas of curriculum and pedagogy to enable transnational learning communities and generate and sustain empowering knowledge networks. There are three main sections to the paper. The first section of the paper focuses on the conceptual framework for the paper by citing the works of James Clifford (1997). The second section examines the internationalisation of higher education in Australia with an analysis based on interviews with transnational students from the People's Republic of China. The final section provides practical conceptual resources for making innovations in education policies, pedagogies and politics through the internationalisation of higher education.

INTRODUCTION

Today, universities around the world, being responsible for higher education are increasingly affected by the process of globalization. Transnational students are using the 'internationalisation of higher education' to acquire skills geared towards a knowledge economy. This paper provides insights into student perspectives- local and international, bilingual and mono-lingual, Majority and Minority World alike, on what makes a quality transnational educational experience in Australia. Taking Appadurai's (1996, p. 33) notion of 'global cultural flows' as a point of departure, it might be argued that the global/national/local movements of transnational students (and academics), and their imaginings about moving, constitute a key feature of the current transitions in the practices of globalisation.

This paper is based on an analysis of interviews with students from the People's Republic of China who were enrolled in the final year of their undergraduate degree, mostly in disciplines related to business, science and technology, at a range of Australian universities. The interviews provide insights into student perspectives on their educational experience in Australia and the value of such an educational experience to their education life chances. From the beginning of this century, Australian considerations of transnational capitalism and politics have extended to China, displacing but not marginalising an earlier focus on Japan. There has been a drift toward economic 'Asianization' with China in particular being a desired trade and market area. Moreover, this focus on Chinese students also invites consideration of the role of non-Europeans in inciting innovations in university teaching and learning in Australia, a country still struggling with its legacy of White Australia politics (Singh, 2001).

The conceptual framework for this paper draws on the resources of James Clifford (1997) who believes that ethnographic fieldwork is changing because the Other is coming to study Europeans, Americans and Australians (Clifford, 1997, pp. 29, 52-53, 60). As a result of the global mobility of transnational students, the borders defining both the 'field' and the 'worker' are challenged and constantly changing. Economic and cultural globalization processes require that the boundaries between insider and outsider and between host and foreigner are dismantled and involve the construction of new boundaries or the reconstructing of old ones because of transnational student mobility. New forms of cultural diversity are being fashioned, grounded in the

Second, the balance of power continues to shift between the 'worker' and the 'field' (Clifford, 1997, p. 41). Pedagogically the focus is on the ethical questions of rapport and reciprocity. Today education is simply one of many different cultural experiences. Within this context, it is important to understand how information flows between channels and environments and seek to stimulate different flows of information. Such thinking also questions the value of using nation-states and geo-political borders as the primary unit of analyses for discussing learning systems. It pushes us to see institutions and policies in terms of horizontally and vertically overlapping layers ranging from the local to global. This is because enabling transnational learning communities is a 'both-ways' educational practice involving the use and collaborative production of knowledge.

Third, co-residence for extended periods has had considerable authority in defining ethnographic fieldwork (Clifford, 1997, pp. 55-60). Clifford (1994, p. 322) finds, 'The empowering paradox of transnationalism is that dwelling here assumes a solidarity and connection there. But there is not necessarily a single place or an exclusivist nation. ... [It is] the connection (elsewhere) that makes a difference (here).' Of course it is a common consciousness or bundle of experiences which bind many people into the social forms or networks. The awareness of multi-locality stimulates the desire to connect oneself with others, both 'here' and 'there' who share the same 'routes' and 'roots' (Gilroy 1987, 1993).

Fourth, the ethnographic quest for a theoretical framework that grasps the complex realities of any given field or site has proven elusive (Clifford, 1997, pp. 48-49). More social scientific studies will help us to recognize how and why, as Nancy Foner (1997, p. 23) puts it, 'some groups [and places] are likely to be more transnational than others – and we need research that explores and explains the differences. Within transnational groups, there is also variation in the frequency, depth and range of transnational ties. Fieldwork then helps students to learn just enough to know what vast levels of empirical and conceptual data remain to be produced. However, without some theoretical scaffold to map the interacting, multi-level patterns in the data, the interpenetration of the local by the national and global, any hope of deepening our knowledge and generating alternative understanding escapes (Singh and Shore, 2004).

Fifth, the power relations of ethnographic fieldwork are being reconfigured as ever-advancing technologies are being deployed (Clifford, 1997, p. 58). Marcus (1995, p. 96) speaks of 'multi-sited ethnography' essential to the ethnographer studying transnational people. Such methods involve 'tracing a cultural formation across and within multiple sites of activity'. Hannerz (1998) adds that 'the research may need to be not merely multilocal but also translocal. …Serious effort must thus be devoted to an adequate conceptualization and description of the translocal linkages, and the interconnections between these and the localized social traffic.' These methods explore possibilities for pedagogical innovations that involve re-inventing ethnographic practices of fieldwork.

The sections that follow seek to provide practical conceptual resources for making innovations in education policies, pedagogies and politics through the internationalisation of higher education. This is perhaps nowhere more evident than in Australia which is increasingly dependent on the cash-flow derived from international fee-paying students. Labor argues that 'human capital investment is at the heart of a third wave of economic reform that will position Australia as a competitive, innovative, knowledge-based economy that can compete and win in global markets.' (Rudd & Smith, 2007).

INTERNATIONALISATION OF HIGHER EDUCATION IN AUSTRALIA

Internationalisation is debated together with globalisation and most often viewed as higher education's response to this phenomenon. In much of the literature, internationalisation of higher education has come to be understood as an all-encompassing concept which can involve international cooperation, but refers, as well, to changes taking place within a given institution through policy and specific initiatives. These latter initiatives are largely framed around meanings of marketisation (Caruana, Ramaseshan, & Ewing, 1998, Gatfield, Barker & Graham 1999, Jolley, 1997, Kemp, Madden & Simpson, 1998, Lafferty & Fleming, 2000, Marginson, 2002, Mazzarol, Choo & Nair, 2001, Mazzarol & Hosie, 1996), compensating for presumed deficits especially in English language education and the imagined allures of 'Anglo-American knowledge' (Ballard and Clancy, 1997, Bradley & Bradley, 1984, Cleverly & Jones, 1976). Alternatively these debates over the purposes of internationalising higher education have dwelt on the psychosocial imaginings of 'absolute differences' in the learning strategies of students from Asia and Australia (Watkins & Biggs, 1996). Invariably they all discuss the growth of ways and means that higher education institutions have found to develop academic mobility for students and faculty.

Australia is increasingly becoming a popular destination for international students particularly from Asian countries. This is attributed to the geographical proximity to Asian countries, language, reputation and flexibility of study and work arrangements. It is argued therefore that research on educational and cultural awareness of transnational students as fieldworkers is an important step in the discourse of internationalisation in Australian institutions. As Portes (1998, p. 2) points out, the concept [Transnationalism] 'may actually perform double duty as part of the theoretical arsenal with which we approach the world system structures, but also as an element in a less developed enterprise, namely the analysis of the everyday networks and patterns of social relationships that emerge in and around those structures.'

To get a sense of the possibilities the internationalising of higher education has to offer the elaboration of the transnational identities students were asked about the connections they had made in Australia. Identity in these conditions is not a static inherited quality, but 'formed out of the strategies for the accumulation of economic, social, cultural and educational capital as transnational Chinese travel, settle down, invest in local spaces, and evade state disciplining in multiple sites' (Ong & Nonini, 1997, p.326). By actively occupying and, moving through and around space the students in the study were able to discursively map the field. Clifford, (1992, p.101) states that cultural groups often have both inside/outside knowledge and experience 'sites of displacement, interference and interaction'. This view of culture has important implications for transnational communities in particular and for ethnographic research in general because it allows us to treat small scale phenomena like student groups as complex, internally coherent cultural groups. The research study with the Chinese students and which is documented in the section below reflects the ethnocentricity of the teaching learning process in Australian universities.

Languages and Cultural Understandings

According to Clifford (1997, p.23) the student-as-fieldworker learns to speak the local language to a level that will foster engagement in local communities without 'cosmopolitan intermediaries'. For some of the students it was more than just learning the language. For Ke Chen (MC, p. 13) this involved learning cultural understandings:

> My education is not just from the university. … I've learnt more cultural things. Sometimes I don't understand what Australians are talking about, and I speak English very well. The words can be understood but I still don't know what they are talking about. That's the cultural understanding I'm learning.

The existence of multiple Englishes was something that Peng (MC, p. 22) discovered: 'In China our English tests are mostly for writing and reading. We had few opportunities to speak English. Our listening was from British or American English; it is different from Australian English.' Likewise Yang (MC, p. 15) recognised that 'English' is not one bounded whole, but a complex tapestry of dialects, if not languages:

> In China we learnt American English which is quite different from Australian English. It was not easy for me to pick it up, but now I … learn English from the lectures, the university

and also from my work. … The more you speak and the more you listen the more you pick up … about routine or everyday life words.

As in fieldwork (Clifford, 1997, p. 57), discursive practices are crucial to the translation, definition and re-presentation of both the 'transnational student' and the 'field' into scholarly knowledge claims. However, questions about the *bilingual* oracy, writing, listening and speaking of transnational students, along with those concerning the rise of multilingual knowledge economies tend to be erased (Singh and Scanlon, 2003, pp. 8-17). hooks (1994, p.8) proposes a particular teaching approach – 'engaged pedagogy'.

She describes this as a learning relationship where 'everyone's presence is acknowledged'. The point behind this argument is that knowledge is relational and the dominant discourse of academic knowledge is not value-free.

Enhancing Deep Learning with Critical and Creative Thinking

The students realised that student voice and lived experiences contributed to the construction of knowledge and the development of critical being, and gave them a stronger sense of self and place. Jun (MC, p. 5) learnt that her 'job' involves not only ensuring a deep understanding but also producing knowledge:

> In China the teaching method is more teacher-centred. The teacher talks too much in front of the class and the students keep silent. They sit there and take notes. If they memorise the notes they can pass the exam. But in Australia it is quite different. The teacher stimulates the student's critical thinking and wants the students to become an independent learner.

They discovered a teaching strategy which encouraged student narratives to become part of the teacher's educational tool and the idea of becoming a worker able to produce knowledge was a source of enjoyment for Xiang (MC, p. 7):

> In China we only learn something that the teacher has told you. … In Australia the teacher only speaks to tell you a little bit, and then you have to do research. … I like the Australian style better because you can do something you like; you can spend more time on it and do things for yourself.

Students indicated that the teaching built on people's lived experiences as a knowledge base to construct new knowledge which was validated by and within their shared social or cultural heritage. This interrelationship between deep understanding and knowledge production underlined Che's (MC, p. 1) comment:

> In China you need to write it down, memorise information, and you get good marks. In Australia … you must analyse the information and figure things out. You need a logical way of thinking to come to your own conclusion. It's a little bit hard for me.

The students obviously felt the teaching to be a positive experience because their views were elevated to an important level by giving value to their beliefs and ways of thinking.

Their fieldwork grounded their theoretical interpretations through enabling them to generate empirical evidence (Clifford, 1997, p. 52-53).

Group-Based Multidisciplinary Projects

Teamwork allowed students the opportunity to elevate their views to an important level ... by giving value to their beliefs and their way of life. For hooks (1994, p. 38), this process is critical to distinguishing between simply listening to those on the margins and according 'their work the same respect and consideration given to other work'.

Su (MC, p. 24) used her insider knowledge to work with others and provide a perspective from a non-insider and yet contribute to the teamwork.

> Teamwork is very important for you to learn to communicate with others. In the group you have to give your own opinion. As other people have their opinions this can help you to think in other ways to improve confidence. … I made friends with students … from places like Hong Kong, Singapore and Malaysia because we were doing the same assignments and projects.

Riu (MC, p. 21) was able to make an advantage of his contacts, facilitating both the representation of different world-views and the emergence of new relationships:

> In Australia, teachers pay more attention to teamwork … and small group discussions … In China … even though it has a big population there is still no teamwork. Having to work with other people is very good experience.

Team-based projects provided Xiang (MC, p. 7) opportunities for building transnational connections: 'I work with people from different countries. I met people in Australia … from Malaysia, Hong Kong, Indonesia, Japan and India.' Likewise Junwen (MC, p. 16) found that her group assignments provided the basis for creating an extended learning community:

> I made some friends when we were doing group assignments and we keep in touch although we've finished the assignments. Most of my friends come from China and other countries … India, Indonesia and some Australian students.

Xin (MC, p. 10) also recognised the benefits of group work: 'We did an assignment and formed a group, and then we got along with each other and became very good friends. We help each other.' However, Xianlong (MC, p. 6) noted some of the complexities of teamwork:

> The course requires you to do group work. Sometimes it's hard to make a group. Several Aussies are in one group while 'Asians' are in another group. … They have an advantage with language over us.

This separation by Anglo-Australian and international students reinforces mistaken presuppositions about there being a spatial distinction between a pure, absolutely different home, and home as being a place of transnational discovery (Singh, 1998, pp. 379-389). Li (MC, p. 8) made a similar point:

> During the lectures and tutorials we don't talk to each other. So most of my friends are from Asian countries. Sometimes we have group assignments. They don't want to join the Asian students for the group.

Perhaps the conclusion to be drawn from these snapshots of the latter students' comments is that some international students did not feel they were contributing to new knowledge and this may require privileging the space of the local in order to contribute to more global. In this way, marginalised students will feel more grounded if the local students made more of an effort to interact and integrate with international students.

Learning Through Part-Time Jobs

Although Chinese students may not be particularly focused on the financial benefits of foreign study, they do need to finance their stay. The considerable efforts which students make in order to finance their education in Australia suggests that many are powerfully motivated. Junwen (MC, p. 16) designed internet web pages for friends; Jiang (MC, p. 25) worked for an e-business, while Jing (MC, p. 17) worked in an Internet café as a receptionist. Most students like Li (MC, p. 8) understood the Australian government's visa restrictions on overseas students working for no more than 20 hours per week during semester and also acknowledged that their parents did not want them to work, preferring that they concentrated on their studies. For Yuan (MC, p. 19) work experience in Australia was a beneficial part of her education: 'I didn't have any experience in working before coming here … it's been useful to have some work experience here.'

The internationalization of higher education reflects the conflict between different aspects of globalization. At one level, globalization provides new opportunities, choices of how to live, the chance to travel and to experience other cultures (Giddens 1991). At a second level, globalization imposes the logic of the market into every sphere of human activity, so that students become economic units.

However from an ethnographic point of view, the student-as-fieldworker participated by being 'adopted' by locals, learning their culture and language, thereby creating a home away from home. They used part-time work to enable them to conduct serious, relatively unobtrusive, and almost panoptic participant-observations (Clifford, 1997, p. 20-22).

For education policy actors the question is how might these experiences and knowledge gained by transnational experiences be reconstituted as public knowledge of educational benefit to all? Transnational education poses a number of challenges to educational providers, students and higher education institutions. It would require a reconceptualization of long and deeply held beliefs about the nature and role

of the university and its relationship to students and the global society. Enabling transnational learning communities aims to provide strategies of education policies, pedagogies and politics that 'accommodate ex-centric residents and travelling culture-makers' (Clifford, 1997, p. 25). Enabling transnational learning communities could represent at the very least, a renewal and re-articulation of the responsiveness and responsibility of education to engage the imperatives of these changing times. The real problem is how to develop complementary approaches to transnational education that suit both national and international needs. To suit both the national and international arena, universities would have to design approaches to education that at the very least clearly identify with quality, relevance and cultural diversity.

Instead of viewing transnational students in terms of oppositions (the dominant vs. the dominated, the oppressor vs. the oppressed), it is also important to note that many students may belong to more than one social category or cultural group and are constantly negotiating between the dominant discourses of their adopted country and the discourses that signify their ties to their native country and various other communities. Critical ethnography therefore allows one to to examine 'transnational connections,' that is how their social networks and identities transcend the totalizing concept of nationhood and in Australian higher education this could mean freeing it from, at least some of its 'history of European, literary, male, bourgeois, scientific, heroic, recreational meanings and practices' (Clifford, 1997, p. 33). Despite an ambiguous inheritance, pedagogies of quasi-ethnographic fieldwork might be reworked along the lines indicated below so as to be useful in enabling transnational learning communities that give form and substance to a new generation of trans-national workers/employers, global/national citizens and worldly learners.

In exploring the educational and cultural aspects of transnational connections, Hannerz (1996) proposes for contemporary ethnographic analysis the adaptation of Bauman's notion of 'habitat' in which agency operates. Lavie and Swedenburg (1996, pp.165-6) calls for its exploration in the practices of everyday life. In their words, 'we stake out a terrain old in experience and memory but new in theory, a third timespace, and we call for its ethnographic examination. This is a terrain where opposition is not only responsive, but creative. It is a guerrilla warfare of the interstices, where minorities rupture categories of race, gender, sexuality, class, nation, and empire in the center as well as on the margins'.

So by re-making ethnographic fieldwork as a method of teaching, the world's geopolitical shifts might be represented to, by and through the learning experiences of transnational students. Students-as-fieldworkers could investigate global/national/local economic, cultural and socio-political flows, including the import-export of higher education in which universities are already enmeshed, to reveal what questionable habits are being taken for granted.

Challenges that extend the students' cosmopolitan outlook

These transnational students displayed agency and control perceived not through the lens of the 'national culture' but through a unique cross-cultural perspective that showed the potential for bringing cultures together for mutual critique and enrichment.

Engaging Multiculturalism and Multiple Racisms

Travel is tainted by its historical 'associations with gendered, racial bodies, class privilege, specific means of conveyance, beaten paths, agents, frontiers, documents, and the like' (Clifford, 1997, p. 39). Despite this, what the snapshots represented below indicate is that there are still sources of potential empowerment for transnational students to engage in practices that develop their intercultural voices and perspectives. Yang (MC, p. 15) saw possibilities for alliances and hoping for connections:

> I heard of Pauline Hanson, such a rude lady. … Australia is a multicultural country … it's democratic… everyone is equal but some are just want to Australia to be a white country. I think One Nation and John Howard are in that group. It's upset me. When I call my family, my mother and father they say, 'It is okay because we have heard from the local newspaper that they said its okay. It's still in the upper level of society, so it hasn't not deepened onto you.' But I can still feel it in some people's eyes, their posture and language.

Xin (MC, p. 10) and Wu (MC, p. 2) were able to develop a sense of agency in making flexible cross-cultural identifications and in critiquing the socio-cultural practices represented in the media. The struggles between different interests within and across nations were hinted at by Xin (MC, p. 10):

> On China's TV they reported that many people in Australia are friendly to Asian people. I saw that as well. So I think that those people here who don't like Asians are not the majority.

Wu (MC, p. 2) wondered about the limitations in the global education, in the Asia-literacy of Anglo-Australians adrift amidst multicultural experiences:

> Some Australians ask me if men in China still have pigtails. I felt very uncomfortable because we have done without that for over one hundred years but they still don't know.

Often local students focus on essentialized and static definitions of culture without understanding the concomitant implications for transnational students. Success in the globalisation of teaching and learning for Ying (MC, p. 14) meant coming to know others:

> Australian students don't want to make friends with Asian students. … I don't know why. I hoped we could be happy together and share our cultures but I really don't know how we can do that.

Without ignoring issues of structural inequality and racism, local students need to recognize the agency of transnational students as they struggle to counter their oppression and function in their everyday lives.

Ming (MC, p. 18) said:

> I can't make any friends with Aussies. … It's very hard for me. … When I first came here my friends in China said, 'You will make a lot of Aussie friends.' But it's hard. I don't enjoy the things that the Aussies do. … they go to the footy. I am not keen on that.

According to Jing (MC, p. 17) transnational students are already expanding their learning in this regard, but it is not apparent that local students are doing likewise: 'We don't have many Australian classmates. … they are all working, so they come to study and don't talk to you at all. … It's quite easy to make friends with international students.' Thus while universities have complex histories of travelling cultures and cultures of travel, it is important that they become ethnographers of the communities from which their students come, especially in situations of cross-cultural contact and in the context of social inequality and racism.

Ying (MC, p.14) remarked that ‘We don’t have a lot of topics to talk about with the English people’, while Su (MC, p. 24) suggests that English may subvert the possibility of Anglo-Australian students having a key role as ‘bridge builders’ between China and Australia: ‘I was afraid to communicate with the Australians because they speak very fast. … I don’t know how to expand. They seem to rush time. … It’s very shameful to ask them to say it again.’

How then might Anglo-ethnic students be explicitly taught to negotiate productive relationships with transnational students? To what extent is one group’s ‘core’ another group’s ‘periphery’? For reformists such as Clifford (1997, p. 204) boundaries can be democratically negotiated and this does not mean moving to a model of multicultural education. As Sleeter (1995, p.90) commented, ‘radical critics regard the increasing popularity of multicultural education as a palliative White response to minority concerns that deflects attention away from structural issues, especially white racism’. (May, 1999, p.1) calls for a critical multiculturalism that is at its core antiracist and that addresses the ‘wider processes of power relations and inequality’ in our society.

Tomlinson (1999, p. 29) argues that while contemporary globalisation promotes the restless movement of people, the key cultural impact of this mobility ‘is in the transformation of localities themselves.’ Walters (1995, p. 35) conceptualises the concept of a global village - where distant events can have their effect on different locations across the world). Bauman (1998) proposes that the reaction of people on the receiving end of these processes is to regroup, forming new, localised identities. Friedman (1994) explains that ‘local’ is not self contained. It depends on its interface with other locales and wider networks. Changes in the political economy of Australian universities are pushing and pulling students and staff in various directions. The Asianisation of Australian universities is a sign of their uneven, non-linear integration into and appropriation of a globalising education industry (Singh, 2002, pp. 217-230).

In terms of aligning their curricula with the economics, cultural and politics of neo-liberal globalism this could suggest actively and explicitly displacing the thinking associated with White Australia politics by giving expression to some form of cosmopolitan multiculture (Singh, 1998, pp. 12-17). If the localities of universities were to serve as a guide for curriculum development, these institutions should have very strong bilingual and multicultural curricula, with elements of the culture of transnational students constituting a significant orientation to the curriculum. The reality of these localities raises challenges for universities, educators and policy makers as they decide on the best ways to educate this student population. Universities need to acknowledge the diversity of their student population and to affirm this diversity in the implementation of curriculum. Pedagogy needs to affirm the students’ cultures by recognising the fact that culture is not static particularly in the case of transnationalism and that issues such as racism and socioeconomic and political inequality threaten the cohesiveness of culture. Similarly, a Euro-centric, English only curriculum cannot represent a curriculum that is multicultural.

CONCLUSION

Universities around the world are being de-structured in response to and as a means of engaging with neo-liberal globalism. This means a strong educational structure should underlie the development of human capital. Universities can play a key role in challenging the hegemony of neo-liberal globalisation and offer alternative visions of global affairs that are more compatible with social justice issues. Burbules and Torres, argued that as global changes occur, 'they can change in different, more equitable, and more just ways' (2000, p. 2). By implication this suggests the possibility of working critically with tools of neo-liberal globalism for they too have to be questioned, and being innovative in the meanings we make of them.

Rudd and Smith (2007, pp 4-5) believe that the 'rise of China and India as economic superpowers brings great opportunities to Australian exporters. But it also brings increasingly intense competition to the global economy, not just in manufacturing, but also in services and knowledge industries. We cannot allow Australia to simply become China's quarry and Japan's beach – we must have a diverse economic base….Australia needs nothing less than a revolution in education – a substantial and sustained increase in the quantity of our investment, and the quality of our education.' A significant constraint on Australia's productivity growth in recent years has been under-investment in education.

What then do the main issues canvassed in this paper suggest for possible university action? Universities need to work for a socially inclusive neo-liberalism with a focus on the development of identity. Courses should focus on critical multiculralism and create spaces for understanding the development of identity. In other words there needs to be a move away from a focus of neo-liberalism with a nationalist focus to one with a transnationalist focus. This in turn requires that the curriculum be culturally relevant allowing students the freedom to attend university without having to sacrifice their cultural identity. Zeleza (2005)

The future of higher education linkages requires bold visions of internationalism, of alternative globalization, that transcend the edicts of market accountability and narrow commercial calculations and embrace the ethics of social accountability and an expansive humanism that will elevate and empower all our people, enabling us to face the enduring and fresh challenges of our existence on this delicate, dwindling, but delightful planet with greater confidence. We must resist the temptation to naturalize contemporary trends and ideologies that debase rather than elevate human dignity. We will have failed the future if we do not vigorously pursue the dreams of a university education as an ennobling adventure for individuals, communities, nations, and the world at large, if we do not strive to create universities that produce ideas rather than peddle information, critical rationality rather than consumer rations, and knowledge that has lasting value.

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Chapter 15

SOCIAL LITERACIES FOR CIVIC ENGAGEMENT IN THE 21ST CENTURY

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ABSTRACT

Jenkins et al (2006) expanded the discussion of media literacy, arguing for a paradigm shift from a focus on individual expression toward one on community involvement. In addition to the skills traditionally emphasized by media educators, a set of social literacies becomes indispensable as students learn to navigate their way through cyberspace. This paper aims to strengthen the case for the social literacies by arguing for their centrality to twenty-first century civic education. It first describes how the emerging participatory culture is offering abundant opportunities for young people's civic engagement: by promoting open and thoughtful civic discourse, by facilitating the mobilization and organization of collective action, and by encouraging the expression of civic voices through media production. It then argues that in order to take full advantage of these learning opportunities, young people need to acquire the social literacies—in particular, the skills of negotiation, collective intelligence and networking.

Keywords: media literacy, Henry Jenkins, participatory culture, social literacies, civic engagement, negotiation skills, collective intelligence skills, networking skills

INTRODUCTION

What is media literacy? According to a widely adopted definition, it is the ability to "access, analyze, evaluate and communicate message in a variety of forms” (Aufderheide, 1993, p.xx). The keyword here is "variety." As time passes, a wide, comprehensive definition

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of media literacy is called for in an age when information comes to people not only through print, but also increasingly through a variety of multimedia forms—television, radio, newspapers, film, advertising, and music videos. Literacy is no longer simply a matter of being able to read and write printed words; students must also acquire the skills to understand, analyze, evaluate and express themselves through the powerful images and sounds of our omnipresent multimedia media culture.

Recently, Jenkins et al (2006) expanded the discussion, arguing for a paradigm shift in media literacy from a focus on individual expression toward one on community involvement. They asserted that our media environment has evolved to a point where, unlike what used to be the case when all media resources were divided among a few transnational conglomerates, a more democratic and participatory media culture, fueled by advances in information technology, is emerging that allows every individual to meaningfully participate in the media landscape through such interactive channels as blogs, wikis, myspaces, discussion boards and virtual communities. Instead of sitting passively before the TV-set, the average audience can now actively participate in a global media community by publishing weblogs, distributing self-made video podcasts, engaging in online discussions or even entering 3D virtual worlds. The change is no longer just the result of the emergence of new media forms other than print; it has been brought about by a fundamental transformation in the relationship between media and audience, a relationship that is increasingly two-way rather than (as in the old days) one-way. Educators, therefore, must respond to this fundamental change by reconsidering what it means to be literate in the emerging participatory culture.

What skills must a media literate person possess in such a culture? According to Jenkins et al (2006), in addition to the skills traditionally emphasized by media educators, a set of social literacies becomes indispensable as students learn to navigate their way through cyberspace. These include play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking and negotiation (Jenkins et al 2006, p. 4). Some of these skills—play and simulation, for instance—are needed for participation in specific tasks of the kind that can be found in online multiplayer games; others, such as negotiation, collective intelligence and networking, apply more generally to a wide variety of activities. However, all of them are needed by young people if they are to benefit fully from the learning opportunities offered by the participatory culture.

This paper aims to strengthen the case for the social literacies by arguing for their centrality to twenty-first century civic education. The argument consists of two parts. The first describes how the emerging participatory culture is offering abundant opportunities for young people's civic engagement: by promoting open and thoughtful civic discourse, by facilitating the mobilization and organization of collective action, and by encouraging the expression of civic voices through media production. The second argues that in order to take full advantage of these learning opportunities, young people need to acquire the social literacies—in particular, the skills of negotiation, collective intelligence and networking.

HOW PARTICIPATORY CULTURE IS ENCOURAGING YOUTH CIVIC ENGAGEMENT

It is very common nowadays to hear people to say that today's young people are largely disengaged from civic life. A U.S. study showed that only one out of ten American youths between the ages of 18 and 29 could name both of the two senators of their state, compared to one in five American adults between the ages of 30 and 45 (Delli, Carpini & Keeter, 1996). Another study revealed that only 32.3% of American young adults reported having voted in the 2000 presidential election, compared to 54.7% of the general voting population (US Bureau of the Census, 2002). Elsewhere it is very much the same picture. In Canada, for example, only 22 percent of eligible 18-22 year olds turned out to cast their ballots in the 2000 election (Centre for Research and Information on Canada, 2004; Cook,2004), and only 31 percent of those Norwegians born after 1975 voted in the 1999 general election (Bjorklund, 2000). Judging from these signs alone, one would definitely have to agree with Robert Putnam's remark that "we face a civic crisis today in terms of young people's civic disengagement (Putnam, 2000, p.173)."

However, such a picture is misleading. It assumes a narrow, outdated conception of civic engagement, which only counts such conventional political practices as voting, displaying campaign stickers and contributing money to political candidates. As a number of commentators have pointed out, this leaves out volunteerism and community service, which are just as good indicators of the extent of young people's civic engagement as is voting or contacting elected officials. Indeed, as the study by Keeter et al (2002) suggests, although young people may not be "electoral specialists", they are "civic specialists", actively engaged in volunteering, working collaboratively on community problems, fundraising, and group membership. In fact, many youths have turned away from conventional politics not because they are apathetic or civilly disengaged, but because ‘they see conventional politics as inherently tied to institutions that seem impersonal and unresponsive’ (Long, 2002, 18). There is evidence that the new media environment may play an integral role in fostering active and informed engagement among e-savvy youth, who are increasingly turning away from mainstream media in favor of the Web, wireless, and other alternative information sources (The Kaiser Family Foundation: Key facts: Media, Youth, and civic Engagement Fall 2004). What students need is a kind of participative, active learning about civics and citizenship (Hahn, 1996; Patrick, 1999).

Furthermore, the picture of young people as civically disengaged is misleading because it ignores much of what is happening in and through cyberspace. To take just one example, as Palmer (2003) points out, the 2002 report by Keeter et al that only 2% of the "DotNet" generation have ever canvassed neighborhoods is misleading as an indicator of youth civic engagement because canvassing—the old-fashioned activity of going door to door to speak with neighbors about a political issue or a particular candidate—has already become obsolete as political discourse increasingly takes place on Internet discussion boards, blogs, and virtual communities.

Contrary to the prevailing pessimism about youth disengagement in civics, there is evidence that demonstrate that the various ways in which the emerging participatory culture—discussion boards, blogs, myspaces, online multiplayer games, even mobile phones—is actively encouraging young people's civic participation: by promoting open and thoughtful civic discourse, by facilitating the mobilization and organization of collective civic actions, and by allowing individuals to express their political voices through producing and distributing media content.

The wealth of civic information on the Web can certainly make a significant contribution to young people's civic education; as Montgomery et al (2004) found, hundreds of NGO-supported "civic websites" exist that instruct and encourage youths to vote, volunteer in the community or donate money to charities. The participatory, interactive use of the Internet offers abundant opportunities for civic engagement on the part of the young.

Participatory Culture Facilitates Open and Thoughtful Civic Discourse

Participatory culture can promote young people's civic engagement by encouraging them to take part in open, informed and thoughtful online discussion of civic issues. Discussion has long been found to contribute to the civic engagement of youths. For example, Keeter et al (2002) found that student volunteers who were encouraged to talk about their volunteer work in class were much more likely to stick with it. Another study of children in 28 countries revealed that schools could best foster civic engagement by ensuring an open classroom climate for discussing civic and political issues (Torney-Purta, 2002).

There is, however, an important reason for thinking that cyberspace discussions can do a better job of engaging young people than classroom ones: unlike face-to-face exchanges, discussions on the Net are usually anonymous and asynchronous. Anonymity ensures that one is not afraid to express one's civic and political values by allowing one to say what one feels without disclosing one's identity. Asynchrony ensures that one has the time to formulate a serious and thoughtful position by removing the immediacy that is inherent in face-to-face interaction. As such, both anonymity and asynchrony contribute to the quality of online civic discourse, insofar as they ensure that nothing is unsaid and what is said is said with propriety and thoughtfulness.

One of the best examples of the attraction of online civic discussion for young people is Voices of Youth, a multilingual discussion board created by the United Nations International Children's Emergency Fund (UNICEF), which features civic discussion in English, French, Spanish, and Arabic. The website is about "linking children and adolescents in different countries to explore, speak out and take action on global issues that are important to them and to creating a world fit for children. (UNICEF, n.d.)" Since its launch in 1995, the website has reached young people in more than 180 countries, more than 60% of whom have been from developing countries. As can be seen from Table 1, some of its discussion threads—all started by youths themselves—have become astonishingly popular, with hundreds of replies and tens of thousands of views. Needless to say, these discussions, which frequently touch upon sensitive issues such as racial prejudice, sex and gay rights, would have encouraged much less participation if carried out in a traditional classroom setting.

Participatory Culture Facilitates the Mobilization and Organization of Collective Civic Action

Participatory culture not only provides opportunities for people to exchange ideas on civic issues: it also brings people together, forming online *communities*—groups of individuals who share a common interest via e-mail, discussion boards, blogs, wikis, chatrooms, myspaces, and instant messages. Such communities encourage their members—the majority of whom are young people—to participate in a variety of collective actions, both online and offline. With regard to offline activities, digital communities have been very successful in organizing and bringing about real-world civic actions and turning young people worldwide into "smart mobs" (Rheingold, 2002). The following examples, divided according to geographical regions, illustrate just a few of the ways in which virtual interaction can lead to real-world changes.

i. Examples from Asia

In Hong Kong, after seeing that a landmark pier that had served the city for nearly 50 years was about to be demolished by the government to make way for reclamation and re-development, the cyber-generation used the blogsphere, an independent online media channel, inmediahk.com, and countless SMS messages to organize a peaceful demonstration against the demolition (Star Ferry, 2006).

In the Philippines, more than one million citizens used SMS to organize street protests that helped oust former President Joseph Estrada. (Uy-Tioco, 2003; Rafael, 2003).

In South Korea, supporters of presidential candidate Roh Moo-hyun used SMS messages, emails and an online collectively published news media channel Ohmynews.com to organize an eleventh hour campaign urging supporters to go out and vote. This online campaign drew young voters to polls nationwide and resulted in a narrow 2.3% election victory for Roh. After the election, it was found that seven out of 10 voters were aged between 20 and 40 and around 90% of them were Internet users (Borton, 2004)

In China, in the days leading up to the "Super Girl" final contest (the Chinese version of American Idol), hundreds of thousands of teenage female fans gathered in downtown areas, put up banners and persuaded passers-by to support their favorite contestant by sending mobile phone SMS "votes." The street canvassing was to a large extent organized through the Internet. (SCMP, 2005; Xinhua News Agency, 2005)

In China, over 500 Guangzhou residents gathered outside a Gome electrical store at almost the same time, whereupon they walked into the store and began shouting slogans like "30% off!" Several hours later, they were able to secure 10-30% discounts on such things as TV-sets, digital cameras and DVD players. This practice, popularly known as "tuangou", or group purchase, was possible only because the shoppers had met on an Internet website and agreed, after careful strategic planning and deliberation, on the product they wanted, the shop they would target, and the time and date of gathering. (Chinese consumer power, 2006)

ii. Examples from Europe and America

In France, Internet and SMS mobilizing played a significant role in the Arab youth riot that broke out toward the end of 2005. According to France's national police spokesman, "what we notice is that the bands of youths are, little by little, getting more organized and are sending attack messages by mobile phone texts" (Smith, 2005)

In the US, deaf students at Gallaudet University used handheld wireless devices to organize a protest that 'led to the ouster of incoming President Jane K. Fernandes—who students and faculty said was autocratic and unable to tackle the school's long-term problems during her years as provost' (Associated Press, 2006).

In the US, over 15,000 mostly Hispanic high school students in Los Angeles walked out of school classes in protest against a House bill that proposed criminal penalties for illegal immigrants. The protest was primarily coordinately by text messaging and MySpace chat rooms (Khokha, 2006).

Flash mob—a group of people arrange via emails or cell phone messages to materialize in a public place, perform some unusual and often silly action, and then suddenly disperse—is quickly spreading across Europe and America. In New York, for instance, more than a hundred people suddenly appeared in a department store and began discussing whether to buy a "love rug" for their "commune," whereupon, to the bewilderment of the clerk, the crowd vanished as rapidly as it had assembled (Wasik, 2006). In Rome, as many as 300 people swarmed a music store asking for fictitious titles (Shmueli, 2003). In Berlin, a group of young adults gathered on a busy street, took out their cell phones, started shouting, "yes, yes!" and then began clapping their hands (Pohl, 2003). Although most flash mobs lack an apparent agenda and thus appear pointless, they can have a positive impact on their members in terms of promoting civic and political awareness. As Bill Wasik, the creator of flash mobs, comments, 'For some people, it is purely funny. For others, it is social—they like being out with people. For others, it is political—just getting out in the streets is a political act' (Shmueli, 2003). "Right now," says Howard Rheingold, 'it's just people wanting to do something silly ... But it shouldn't come as a surprise when this becomes a major outlet of political activism soon as well' (Pohl, 2003).

The mobilizing power of digital communities is also well-supported by empirical research. According to a recent study by USC Annenberg School, over one fifth of the members of online communities take action offline at least once a year for a cause related to their online community. Nearly two thirds of online community members report that they now participate in civic causes that were new to them when they first went online, while more than 40 percent have engaged in civic activism more since they joined online communities (Center for the Digital Future, 2007).

Not only is cyberspace a great organizing tool for offline civic action, but it is increasingly becoming a hothouse for civic engagement itself. Numerous non-profit websites exist that allow average users to start online petitions, many of which have collected hundreds of thousands of signatures around the world. Civic engagement has even spread to 3-D virtual worlds such as Second Life. For example, hundreds of avatars in Second Life convened at "Capital Hill" in a recent peace demonstration opposing the Iraq war; the demonstration generated considerable press attention, and its organizer, Ruby Sinreich, was even interviewed by the British Broadcasting Company.

Participatory Culture facilitates individual expression of political voice

I agree that civic involvement will increase, but not in the way that we traditional measure it—through voting or organizational memberships. I think the Net will create entirely new forms of civic participation, much of it using new media tools. Consider the creation of political advertisements, movies, and web sites in the current presidential campaign—mostly done by individual. These are new routes to civic engagement.—Jan Schaffer, J-Lab: The Institute for Interactive Journalism (Pew Internet & American Life Project, 2005)

According to Jenkins et al (2006), one of the central characteristics of participatory culture is its ‘relatively low barrier to artistic creation and strong support for creating and sharing one's creations’ (p. 3). More than any previous media, the Internet makes it possible for anyone with a certain level of skills and technical resources to create his or her own media content and to make it widely available on a global scale. Before the advent of the Internet, media educators often found it difficult to find a real-world audience for students' media productions. Now, with sites such as YouTube.com, Flickr.com, Google Video, and a whole host of text, photo and video blogs, the average student can act as citizen journalists, reporting to a global audience on civic topics that conventional newspapers tend to ignore, or throwing new light on topics already reported. The following are just a few examples:

After a San Francisco State University student put footage online of a protest against military recruiters at the university's career fair, hundreds of protesters surrounded the recruiters, shouting anti-racist and anti-sexist slogans and demanding that the recruiters to leave immediately (Hua, 2005).

In Los Angles, a police investigation was launched after a YouTube video appeared showing two police officers repeatedly punching a man in the face while he struggled (BBC News, 2006).

After Mostafa Tabatabainejad, a UCLA student, was stunned with a Taser gun by the campus police for failing to produce a student ID, a six-minute student-shot video appeared on YouTube showing Tabatabainejad screaming in pain as he was stunned several times . The video prompted widespread criticism of the police, made national headlines, and was followed by 200 students marching to the police station to protest the brutality (MSNBC News Services., 2006).

WHY STUDENTS NEED TO BE TAUGHT THE SOCIAL LITERACIES

This population is both self-guided and in need of guidance, and although a willingness to learn new media by point-and-click exploration might come naturally to today's student cohort, there's nothing innate about knowing how to apply their skills to the processes of democracy—Howard Rheingold (2006).

Are young people in need of guidance as they engage in online political debates, join in online civic organizations and distribute their video productions? Some people might argue that as "digital natives," today's young people can be expected, all by themselves, to handle (or at least learn to handle) such tasks with ease. However, as the quote above by Rheingold suggests, technical ability does not automatically lead to civic and democratic competency. Active participation in the democratic process requires one to be able to listen to, to collaborate with, and to effectively influence other citizens. These are all social rather than technical skills, and there is no reason for supposing that the problem of equipping young people with such skills will disappear once the locus of civic engagement moves online.

Negotiation Skill

As students learn to debate civic issues in cyberspace, they need what Jenkins et. al (2006) call the skill of negotiation—the ability ‘to travel across diverse communities, discerning and respecting multiple perspectives, and grasping and following alternative sets of norms’ (p. 52). This is because while the anonymity of cyberspace ensures that participants can say what they think without worrying about adverse consequences, it also encourages in them a tendency to make verbal attacks and denigrating comments, a situation that is often exacerbated by the sensitive and divisive nature of civic topics.

A particularly interesting example involves a political protest in the online virtual world of Second Life. The protest began on January 15th, 2007, in reaction to the Front National, a controversial French political party that has been accused of expressing fascist tendencies, opening their virtual world headquarters in Second Life. At first, the protestors merely waved signs outside the Front National "headquarters", but the peaceful demonstration soon escalated into a violent exchange of "weapon fire" between members of the Front National and protesters, which ultimately resulted in the destruction of the building. When asked by a reporter whether it would have been better to debate with the members of Front National rather than resort to violent actions, an avatar protestor answered: ’No. With this [sic] persons we can't debate or ignored [sic]. We can't because it's not acceptable’ (New World Notes, 2007).

This and other examples suggest that when young people engage in civic discourse in cyberspace, they often lack the social skill of respecting and understanding the perspective of dissenting others. As a result, online civic discourse between youths (and, many would say, adults as well) often degenerates into meaningless squabbles or even outright hostility. Obviously, such low-quality discourse can do little good, and probably a lot of harm, for young people's civic engagement. It is imperative, therefore, that educators "help students acquire skills in understanding multiple perspectives, respecting and even embracing diversity of views, understanding a variety of social norms, and negotiating between conflicting opinions” (Jenkins et. al, 2006 p. 53).

Collective Intelligence Skill

Another skill that Jenkins et al (2006) identify as indispensable to life in the emerging participatory culture is that of collective intelligence, the ability "to pool knowledge and compare notes with others towards a common goal” (p. 39). In the modern workplace and in such cyberspace communities as Pokémon and Matrix fan communities, what is valued most is not individual talent but teamwork and collaboration. To participate meaningfully in the new participatory culture, students must acquire the skills to work collaboratively on a problem with others in the same social community.

The skill of collective intelligence takes on added significance as students learn to participate in civic actions that are increasingly mobilized and organized through cyberspace. It might seem as though Internet-based civic action were simply a matter of receiving e-mail notices from the organizers and making sure that one appears at protest rallies at the right time. However, this is far from the case. Successful civic actions almost always involve the active input of a large number of participants, and thus it is crucial that each participant has the ability to collaborate with others in sharing knowledge, developing strategies and confronting new challenges as they emerge.

One example in this regard is MoveOn.org, the extremely successful US-based political group that organizes and informs an online community estimated at more than three million people. According to a CNN report, the website's success stems from the fact that "any member can propose priorities and strategies to which others can respond, and the most-supported ideas rise to the top. That means ceding control over much of the content to motivated online participants, producing interactivity that adds grassroots credibility (Associated Press, 2004). According to John Neils, an analyst of the success of MoveOn.org, ‘[MoveOn.org is] an incredibly fluid, bottom-up approach to decision-making, allowing MoveOn to adapt and change as they go’ (Neils, 2004). Evidently, mobilization on the Net is anything but a traditional, one-way process.

Table 1. Some of the most popular threads on the Voices of Youth discussion board.

Thread	Replies	Views
Are males more important than females?	269	47,721
Why are Muslims discriminated against?	215	28,424
Are you an Anti-Bush?	516	53,193
Why can't girls get education?	114	18,550
Underage sex: Should the girls be punished or allowed scot-free?	61	37544
What can we do to stop the spread of HIV in children?	90	17510
Should gays and lesbians be allowed to adopt children?	424	57955
An arranged marriage? Is it right?	117	24647
Polygamy... Is it wrong... or is it WRONG?	197	26104
Should gays be given the right to marry?	150	7057

Networking Skill

Another central skill that young people need is networking, the ability to search for, categorize, evaluate, and disseminate information. Particularly noteworthy here is the ability to disseminate information, i.e., the ability to use cyberspace to present one's own media production to the cyber public. This is especially vital when it comes to media production that deals with civic issues, because unlike purely artistic productions, civic media productions are pointless unless they can reach a relevant public and at least have the potential for prompting civic actions.

It is important to note that the skill to disseminate media creations is something that is almost not taught in traditional media education programs. To the extent that media production is covered at all (and it frequently is not; see Hobbs, 1998), it often focuses more on the technical and artistic aspects of production processes than on their social dimensions—how to reach a wide readership for one's creation; how to increase one's media visibility, and so forth. Presumably, this stems from the perception that with the mass media being divided among a few huge, transnational conglomerates, it is hardly possible for the ordinary individual's voice, not to mention that of a student, to be heard by a wide audience. Yet, such a notion is outdated in an era of increasingly participatory media where the average media producer is just a few clicks away from a global audience. With our media culture becoming increasingly participative, educators can take advantage of this opportunity to teach students the skills they will need in effectively conveying their public voices.

CONCLUSION

Through media, young people's awareness of economic, political, as well as social issues will be increased, as images received from the mass media will motivate them to discuss and learn, leading them to inquire into, and understand, issues in society, in order to become better participative democratic citizens (Buckingham, 2000; Kubey, 2004; Cheung, 2005).

Media literacy education originally arose in response to the mass media revolution. With the advent of radio and television in the early part of the twentieth century, there was a realization that sounds and images would become capable of competing with, even in some cases replacing, words as a major source of information. Furthermore, it became apparent that the producers of sounds and images—radio stations, TV networks, film companies—unlike writers, poets and academics, were often owned and controlled by large, powerful organizations driven solely by the desire for profit. The challenge facing educators, then, was to equip students with both the ability to read and write in the language of the new media, and at the same time the ability to think critically about the messages they receive from what are in effect money-making enterprises.

The recent decade has witnessed another major media revolution, one that has fundamentally changed the media-audience relationship. Unlike the mass media revolution preceding it, the Internet Revolution has not brought a new language for encoding information: most of the material on the Web is still stored in words, sounds, and images. Nor, it seems, is the Internet largely owned and controlled by profit-driven organizations. The revolutionary message of the Internet, instead, is that it is a medium where the audience can become active participators as opposed to passive receptors, where the ordinary person can listen to, collaborate with, and influence other ordinary people just like him- or herself. Participation and involvement are the central message of the Internet Revolution.

Educators need to respond to the Internet Revolution by reconsidering what it means to be literate in an age of blogs, instant messages and virtual communities; in the same way that they responded to the mass media revolution by reconsidering what it meant to be literate in the age of TV pictures and radio sound bites. As I have argued in this paper, the emerging participatory culture calls for skills and literacies that are social, communal and collaborative in nature. Students need to be able to negotiate between dissenting perspectives, to collaborate productively with others on a common task and to effectively communicate their civic voices to a relevant audience. Only by acquiring these social literacies can they tap into the abundant opportunities that the Internet is offering for their civic engagement.

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Chapter 16

A REVIEW OF ATTEMPTS IN DEVELOPMENT OF TURKISH SCIENCE CURRICULUM FROM A HISTORICAL PERSPECTIVE

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INTRODUCTION

A rapid and dynamic change in science, technology and social life is being experienced around the world. Nations, which want to adapt themselves to this change and have adopted continuous advancing as a principle, attaches special important to science education (Ayas, 1995; Ünal, 2003). No doubt, quality of education programs is a determinant in quality of science education. Therefore, it seems that innovative and enterprising changes to be done in science education may become possible if education programs are contemporized.

To raise quality of science education, studies on program development should be continuous and novelties in science and trends in education area should be taken under consideration during this process (Ayas et al., 1993). In addition, failing aspects of current and previous programs should be determined and faults, which have occurred in the past, should be discovered within program development process. Accordingly, investigating the programs, which have been developed in the historical process, from the point of view of planning, practicing and evaluating has an important role in improving quality of the programs to be developed in the future.

Due to this reason, the science programs, which have been developed in Turkey, are presented in this study in chronologic order with a criticizing point of view by considering program development processes.

Classical Period (…-1960)

The law code on Unification of Education (Tevhid-i Tedrisat kanunu) was put into force in 1924 just after proclamation of the republic and according to it, all educational institutes were gathered under the management of Ministry of National Education (MNE) and school programs were significantly modified. Main theme in these modifications performed in educational programs consisted of secularity, turning face to the west and positive sciences. The term of syllabus ("Müfredat Programı"), which means a list of courses and subjects, was used for long time in our country instead of educational program; however, the comprehension of development of contemporary educational programs did not reach Turkey and take place in educational practices until 1950s (Varış, 1996; Demirel, 1999).

Targets of Turkish educational system were specified by considering recommendations, which were done by both Turkish and also foreign educationalists as a result of their studies, until 1950s. However, by these years, John Rufi, who was an American consultant, concluded that these targets could not be achieved in practice as a result of his visits to many schools in different regions across Turkey. The role of educational programs in occurrence of such result is naturally significant (Ayas et al., 1993).

Studies on program development were mostly considered as listing courses and preparing lists of courses and subjects in Turkey within this period and as a result of this idea, classical syllabuses were made by employing traditional method for specifying educational programs. This method essentially consists of the following steps:

- The committee for practice and discipline (Talim ve Terbiye Kurulu) under the management of Ministry of National Education specifies targets of school programs as general statements.
- The list of the subjects to be taught according to these targets is published in the Journal of Notifications (Tebliğler Dergisi) and then, they become official and are put into force.
- Books are prepared according to the specified targets and subjects.
- One of these books is selected as schoolbook and then, the process is completed.

The most important deficiency of the efforts made for program development within this process is the fact that any evaluation cannot be done to determine effectiveness of these developed programs (Demirbaş & Soylu, 2000).

Teachers have an active role in programs, which are prepared according to the classical comprehension, and they are taught by their plain speech, asking-answering and demonstrative experiments. Science books, which are prepared according to these programs, provide information about scientific methods by using plain descriptions and science is not associated sufficiently with the environment surrounding students. Such arrangements discouraged students from science. Learning by understanding could not be performed. As a result, students that most of them are clever did not select basic sciences as profession. In brief, it caused failures (Demirbaş & Yağbasan, 2005).

Efforts were begun to be made for developing a more comprehensive program between the years of 1953 and 1954 considering negative points of the current educational system of our country. Accordingly, the school system containing multi-purpose programs was put into practice in 1953 in various regions across our country as the first attempt for realizing it. However, this attempt could not be effective as much as expected. Another attempt was preparation of a draft program, which could be deemed that it might lead the efforts in developing program for secondary education. This draft program was performed in Istanbul Girls' High School in the academic year of 1954-1955. This draft program was prepared in general by considering the current educational system in our country, educational systems of developed countries, views of foreign educationalists, who were invited to Turkey, and the views saying that education should be arranged according to students' development and needs. This program was tested at certain schools and compared by using experimental methods. As a result, it was seen that the students, who were educated through this program, were more successful and also had superior skills compared with the students educated through the classical program. However, despite this, it could not be made prevalent across the nation (Varış, 1999; Ünal et al, 2004). It is worth paying attention to these programs' "compact" and "heavy" appearance in those days compared with today's programs.

Modern Period (1960-1985)

Developments, which were experienced in science education in many countries across the world, marked this period. The most significant development in science education was experienced after the World War II. Russia launched the first satellite into the space in 1957 and this motivated first USA and then England and other developed western countries. Technological competition, which occurred between developed countries, made the need for manpower educated well in mathematics and science clearer. Nations, which did not want to get behind in this technological competition, found the way by developing new and contemporary science syllabuses (Ayas, 1995). As a result, the groups including many scientists developed education programs after mid-1950s like PSSC (Physical Science Study Committee), CHEM (Chemical Education Material Study) and CBA (Chemical Bond Approach), SMSG (School Mathematics Study Groups) and BSCS (Biological Science Curriculum Study) in US with the support of NSF (National Science Foundation). These studies essentially embraced renewing mathematics and science curriculums. Some tasks, which had become meaningless, were replaced with new ones, which could be used by people in explaining the events that they encountered during daily life. Furthermore, laboratory booklets, guiding materials for teachers, films and educational tools took place in these developed programs. These studies were translated into Turkish and tested at some schools like many other countries. To develop science education, a center was established for building and repair of educational tools in 1961. Also, the Center for Educational Films was made the Center for Film, Radio and Graphics and scientific educational programs were started on radio for schools in 1963 (Çilenti, 1985; Ünal et al, 2004).

The most comprehensive project for modernization of science education in Turkey is establishment of science high schools. The project was performed by Ministry of National Education, Turkish universities and Florida University in USA jointly according to the agreement between Ministry of National Education and Ford Foundation. According to the project, after the works for modernization of secondary education were completed in Turkey, Science High School was founded in 1963 in Ankara and started educating 100 students in

1964 (Demirbaş & Soylu, 2000). Scientific educational programs, which were implemented in Science High School, consisted of not only schoolbooks but also very materials like a detailed guidebook for teachers, publications, which were helpful for teachers, educational films, laboratory tools, which were specifically designed, experiment guide for students, supplementary books for students, tests and evaluation tools. Therefore, scientific educational programs mean all these materials rather than a list of subjects to be taught (Demirbaş & Yağbasan, 2005).

"The Scientific Committee for Developing Science Education" was founded in early 1967 and it was resolved that scientific programs were modernized by this committee. According to the recommendations of this committee, it was resolved to spread the efforts made for developing scientific education in cooperation with the Scientific and Technological Research Council of Turkey (TÜBİTAK) and financial supports of Ford Foundation over Turkey by enlarging them through the project of BAYG-E-7. One of the works implemented to develop scientific education is the project of BAYG-E-14, which was designed by Science High School. This project was performed at three classes of the selected 9 high schools and the matters of teaching basic principles and concepts in mathematics and science subjects and developing laboratories, schoolbooks, supplementary books and other educational materials to make students acquire capacity to think were taken under consideration. The test results were evaluated and the project of BAYG-E-23 was designed to practice the program, which was developed by the project of BAYG-E-14, at more schools. This project was practiced at 100 high schools and 89 teachers' schools between 1971 and 1976 (Demirbaş & Soylu, 2000).

A committee was founded for investigating status of the works, which were carried on since early 1960s for science high school. The results from evaluation were published by the committee for practice and discipline (Talim ve Terbiye Kurulu) of MNE in 1983. The results from evaluation took place in the committee's report on evaluating status of science programs as seen below:

- Students are adapting themselves to the new programs more easily.
- Laboratorial activities and personal studies are more attractive to students.
- Views and attitudes of students and guardians about laboratorial activities and practices, which are performed at schools, are positive. Therefore, they wish that their children study at these schools.
- Number of students exceeds 40 in a class due to intensive demands of families and therefore, laboratorial practices cannot be conducted sufficiently.
- Many cannot be taught due to intensive contents of math and science subjects.
- There are no educational tools and materials required for the project at some schools while others cannot use them efficiently because these materials cannot be produced sufficiently and sent to all schools.
- "Mobile Guidance Teams", which were established to find and eliminate failures, which are encountered during the practice process of the project, lost their function after a while.
- Because the project is evaluated after it is completed, the obtained results cannot help programs sufficiently.

- Managers and teachers working for the schools included in the project have weak information on modern science programs and how they perform these programs (Demirbaş & Soylu, 2000).

According to the aforementioned items, it is understood that the required substructure for practicing the program was not complete. Despite these challenges, the project was performed at more schools including vocational and technical schools. As a result, although this project, which was implemented by MNE, was comprehensively evaluated, the results from the evaluation were not taken under consideration (Ünal et al, 2004).

Missions of the Scientific Committee for Developing Science and Math Education under the management of the Committee for Practice and Discipline and the organizations under the management of it were terminated because the protocols between MNE and TÜBİTAK relating to science project were not renewed on 31st of May 1980 and assistance of Ford Foundation was ceased also. Thus, modernization works for improving science education at secondary schools continuing since 1960s stopped and then, completely abolished in 1984 (Çilenti, 1985; Ünal et al., 2004)

The Period of Activities for Developing Comprehensive Programs (1984-)

Renewing process for science programs was started in 1980s due to the deficiencies of the program applied in 1970s in our country, insufficient human resources suitable for the program and similar reasons (MNE, 2007). Accordingly, Ministry of National Education accepted a new program model in 1982 in cooperation with scientists working for universities and this was published in the Journal of Notifications with the number of 2142. This model requires the programs to be prepared according to the subjects within the aspects of target-behavior-function-evaluation. However, any academic program, which was prepared at secondary education level according to this model, cannot be seen among those published in MNE's Journal of Notifications (Demirel, 1998). Some commissions were established to design a new syllabus after the modern programs had been left in practice. These commissions consisted of teachers, MNE's inspectors and academicians from science departments of universities. These commissions were asked to write schoolbooks in a short term. Then, they wrote schoolbooks by considering subjects and targets of modern programs essentially. As a result, the practices, which were based on schoolbooks, were re-started although they were experienced before and characterized as classical system. Each commission designed a syllabus for its scientific branch based on schoolbooks relating to this scientific branch. The object, target and contents of these new syllabuses were published in the Journal of Notifications with the number of 2197 on 7th of October 1985 (Ayas et al., 1993; Ünal et al., 2004).

Features of this program:

- Targets, which were described very superficially and expressed in common phrases, and headlines of subjects, which should be taught, took place in this new science program. The activities for functioning and evaluation were not explained clearly.

Therefore, teachers had to design and plan the activities required during achieving the targets and teaching the mentioned subjects (Ayas et al, 1999).

- Education at schools in this new program needed schoolbooks, chalk and blackboard. Observation, experiment and research aspects were neglected compared with the modern programs (Akyüz, 1989; Ünal et al, 2004)..
- Because teachers, who would perform these programs, were not educated on job and works for trial-correction-expand were not conducted, the developed program accounted for a counterpart of the classical science program (Ünal et al., 2004).
- 1985's high school 2nd grade's syllabuses were two types consisting of science and literature. Significant variations existed between these two syllabuses from the point of view of content. Subjects were taught in detail in the syllabus focused on science while they were summarized and taught in a short time in the literature syllabus. Furthermore, some topics were lack in the literature syllabus while they existed in the other. For example, "Solubility in solutions having common ion and selective precipitation" existing in the science syllabus did not take place in the literature syllabus. Syllabuses for 3rd grade of high school consisted of 3 departments, which were science, math and literature. Although science and math syllabuses were prepared separately, there is no significant variation between them. However, there are important lacks in the literature syllabus. This indicates that students graduated from different branches have no equal opportunities.

Ministry of Natural Education put the "Passing subject-credit system" in practice in the academic year of 1991-1992 at secondary education instead of passing the class at the end of the year. This may be describes as passing subjects according to the terms. "Passing subject-credit system", which is called as the system with options or individualized system also, is based on the philosophy of accepting the student as an individual along with its interests, targets, skills and expectations (Akdeniz, 1995). The basic principle in this system is the fact that learning cannot be achieved without individual participation and direct teaching cannot lead to constant and meaningful learning. This system has two essential characteristics. First of them is to put the individual in the center of the education. The other is flexibility. This means that the rules regulating course of the learning are not strict. The variation of this system from the previous one is that it requires passing the subject instead of passing the class. This system aims to educate the individual suitable for his/her interests and skills in theory; however, many negative issues and lacks surfaced during the practice. Lack of tools and insufficiency of teachers embarrassed significantly studying common and optional subjects especially at technical high schools and classical high schools existing in towns. Therefore, students started to learn subjects in other schools. This disturbed ambience of schools and control of students became hard. Also, comprehensive teaching could not be provided for students on subjects that they were interested in and the results expected from the system could not be achieved. It seems that point of view on education, which was seen in 1971, is dominant (Ayas et al, 1999; Akdeniz, 1995; Ünal et al, 2004).

MNE made another arrangement in the academic year of 1995-1996 considering negative points of subject passing-credit system. In this arrangement, failures of subject passing-credit system and class-passing system, which had been in practice before 1991, were tried to be eliminated and a class-passing- branch selecting system was built. This system is similar to the previous system due class-passing system and similar to the credit system because it allows students to select branches and departments suitable for their interests and skills. Selective programs, which were in effect from 1996 to 2007, took place in the system as the last practice of this process (MEB, 2007). The program practices allowing students to select a branch is a product appeared as a result of innovative and developing philosophy of Turkish education system. The culture accepting change puts the individual in the center and it also has caused an academic comprehension putting the student in the center through education. This new practice aims that the student joins into the life with his/her specific characteristics by emphasizing his/her gifts, skills and capacity as well as interests. On the other hand, it prepares his/her for education in university according to his/her skills and abilities. Target of such programs is to provide an opportunity for students to select the most suitable area for themselves according to their interests and gifts (Doğan, 2003). Therefore, the first grade at high school (9th grade) is considered as "orientation" grade. This is described in 7th Article of MNE's regulations on class-passing at secondary education as below. Education programs consist of common subjects covering general information, area/department subjects and selective area/department subjects as well as other selective subjects in a way to satisfy their personal differences and demands of area/department to which they shall tend according to their wishes and abilities.

Area/department subjects: They lead the students to the higher education department or profession that he/she plans to study and provide opportunity for him/her to develop to achieve this target.

Selective area/department subjects: They provide opportunity for the student to study the area/department in which he/she is interested comprehensively and information in detail.

At schools, whose programs includes more than one area, students, who have passed the 9th grade, tend to or are motivated to the certain areas according to their interests, wills, gifts, skills and their state in subjects. The relevant assistant of school manager, the teacher responsible for the class of the student and the guiding teacher lead the student by consulting his/her guardians.

Fate of the program practice including class-passing-area selecting has been same with the various practice attempts tested before. The new program, which was produced without analyzing the current structure and the new values, which have been emphasized by the culture requiring change, has encountered inevitable problems, which had been experienced during the practice of previous programs. The previous programs also contained targets, remarks, subject headlines and subheadings. Although defects of the previous system were discovered, a program was designed with the same content and practiced. Then, this caused failure. Such short-term modifications caused regression in our education system rather than advance. Furthermore, it caused waste of time and financial losses. Because whenever a new government came into power, it tried to build a program according to its policies, many programs, which were weak in function, were produced. This program essentially aims to highlight specific gifts, skills and interests of students. However, it cannot be said that students, teachers and learning atmosphere are considered much.

A separate and detailed science (physics, chemistry and biology) education program was designed by EARGED (the Office for Research & Development of Education) in 1997. This was different from the program development studies, which had been conducted until that day. The basic aim of these programs is to ensure that the individuals, who will build scientific society, get used to solve problems with mutual scientific approach (MEB, 1998 a, b, c). These program drafts were designed as not only a document in which general objectives and subjects were listed unlike other education programs but as a material containing objectives, targets, activities for students and teachers and evaluation process separately for each process. Demand analysis reports, developments in science and technology, views of experts, the relevant literature, current programs and books available in Turkey and the world were used while general targets of the subjects were being designed during the preparation process. Targets were made base for specifying subjects. A way was followed in specifying targets and behaviors so that students learn the subjects well instead of by rote and use what they learn in their daily life. How to teach each subject was explained by providing examples. Methods took place in the program putting the student in the center and most of them may address sensorial organs. These programs were tested at 50 schools across Turkey and all of them with the exception of biology education program were evaluated as unsuccessful (Ünal et al, 2004).

Failure of the programs in achieving the expected results caused variations in program development approaches. These variations are a result of program designing approach based on subject or concept appeared at abroad in 1980s. This approach has been started to be adopted by many science teachers in recent times (Demircioğlu, 2003; Özmen, 2002; Yiğit, 2001; Karamustafaoğlu, 2003; Sarı & Tarhan, 2003). The approach increases responsibilities of teachers in program design process. Then, this responsibility brings teachers to develop their capacity in planning, practice and evaluation stages in program designing. Furthermore, it requires teachers to have a researcher identity generally in the class (Yiğit, 2001). To design a program based on a subject, a subject is specified and then, it is investigated to determine the points, which cannot be understood or misunderstood or understood insufficiently by students. At the second stage, alternative strategies are developed to eliminate deficiencies and a draft program is prepared. At the last stage, these strategies are practiced in a class. The required arrangements are done according to the data obtained from the practice and the program is completed (Ayas, 1995). This sort of programs makes contemporary learning and teaching approaches base for different subjects in different areas and they are increasing day by day.

Like many nations, Turkey joined to TIMSS and PISA, which are among measurement and evaluation studies conducted internationally, to evaluate its current program development studies and to determine its position in education area. According to TIMSS (1999) reports, Turkey is at 33rd rank among 38 countries in general order (Bağcı Kılıç, 2003). In PISA (2003), it is 36th among 41 countries in science area. Also, the country in where variation in success between schools is the highest is Turkey. These negative issues require studies in program design and evaluation to ensure especially that students approach the events scientifically, solve them and reach the information by themselves (http://earged.meb.gov.tr/pisa/dil/tr/sunum.html August, 2009). Therefore, MNB has started a reconstruction to design applicable programs for offering to the use of teachers to increase success of students at schools. Accordingly, a constructive educational approach has been highlighted. This approach focuses on students to improve their mental skills for achieving the information instead of changing students' behaviors with teacher-centered approach. Science education program of 9th grade of secondary education was designed according to this. It aims to grow individuals, who are aware of their individual and social responsibilities as well as scientific concepts and principles affecting their lives, within the range of Turkish national education's main targets. This program was put into practice in 2007 (MNB, 2007). This program addressing secondary education tries to surface the information acquired by students previously. Efforts were made for a rich content and easiness in practice. Previous programs and the programs, which were applied by other countries, were examined while this education program was being designed under the scope of secondary education project and it was integrated with contemporary information. The adopted approach requires contributing superior thinking skills (analysis, synthesis, evaluation), considers cognitive processes and aims achieving information by constructing it. The approach partially bears traces of multi-intelligence theory. Also, integration with the world and EC standards were taken into account. Activity examples for teachers did not exist in previously designed programs. Considering this, activity examples are recommended in this new program. The comprehension considering only the results was replaced with an approach considering the process in measurement-evaluation.

All programs, which were designed and put into practice until today, specified only headlines of the subjects but left significant program inputs like explanations about how to teach them, class activities, timing and measurement-evaluation to the books written on these subjects. These books were used as a criterion for specifying deficiencies and overages of the books to be written according to the same program.

This program projects to observe learning process of students through measurement-evaluation process and to employ the information and skills acquired by them in learning process to change learning activities used when required. Evaluations studies should be conducted simultaneously with teaching activities as much as possible suitable for targets and acquisitions of the subject. In other words, evaluation process should continue side by side progress of learning. The evaluation of science subject tests capacity of students for producing solutions for problems encountered during their daily lives by employing the information and skills that they acquired during learning process, in other words, their capacity in using their acquisitions in their daily lives. Some students express themselves better in discussions while others in writing or oral presentation according to personal variations. Therefore, it is important to use different methods and tools together in evaluating students' success in this program. Teachers use the tools evaluating students' performance like observation-monitoring forms, posters, interviews, projects, performance jobs beside traditional measurement-evaluation methods like tests with short answer, long-answer, multiple choice, true/false, matching etc in evaluating students' skills and attitudes.

RESULTS AND RECOMMENDATIONS

A significant progress occurred in program development studies in historical process in Turkey as seen in those explained above according to periods. It can be assumed as a hopeful advance; however, international TIMSS and PISA studies show not very well results for Turkey. This result may be deemed as normal considering logic and rules of program development because program development should not be evaluated alone. Teachers, who are a significant component of the process, are not supported during their teaching education by the faculties or on the job by MNE's Presidency for Training Office on Job and they are not assisted to be ready for the new program sufficiently. The change can function and survive only if teachers are made acquire its philosophic and pedagogic aspects of the program. (Fullan & Stiegelbauer, 1991). Therefore, program development studies, which are not considered as very successful, should be supported significantly by training teachers at the same time.

The second point is the fact that unfortunately, experiences acquired during practice of previous programs cannot be used as guidance in designing new programs. Programs, which are deemed as unsuitable or inefficient, are replaced with new ones. As a result, the experiences acquired during practice of previous programs cannot be used to improve any new program. Those mentioned above documents effects of program development trends experienced in foreign countries. However, our specific experiences cannot be employed in novelties (Çalık & Ayas, 2008). Therefore, new program development studies should be based on the experiences after they are evaluated by independent authorities and should contain contemporary developments.

Finally, some local facilities should be used in developing and practicing science programs to allow students make their environment integrate with science. However, it is not an easy task to do it in countries having centralist education system like Turkey. Therefore, program development studies should be flexible to employ some local facilities or main targets and priorities of the country should be specified and then, more suitable programs for a region should be developed by local commissions with participation of teachers and academicians existing in that region. Surely, a central control mechanism may be required for accreditation and to minimize variations between regions. Thus, the opportunity to be successful in international exams like TIMSS and PISA occurs naturally.

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Chapter 17

QUALITY AND EDUCATION FOR SUSTAINABLE DEVELOPMENT: CURRENT CONTEXT AND FUTURE OPPORTUNITIES

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SUMMARY

The changing context for quality assurance and enhancement in education in the UK and elsewhere presents both an opportunity and a challenge because it offers the possibility of integrating sustainable development into all quality systems. One consequence is the alignment of a number of policy developments to provide a more coherent and integrated approach to performance management and relevant outcomes in our education institutions. More fundamentally it raises the following questions:

- Should sustainable development be an integral component of all quality assurance processes and standards in our education systems?
- Does education which embraces sustainable development contribute to a transformative learning experience and thus better performance by learners?

This paper assesses current developments in quality assurance and enhancement in the UK's education sector and how this evolving agenda is approaching the question of integrating sustainable development within it. It also questions how far current processes of promoting sustainable development might contribute to student performance and to the development of good practice in teaching and learning.

INTRODUCTION

'Sustainability is hot topic these days' proclaims a government education website.[1] Alongside climate change, poverty, HIV AIDS, food shortages and peak oil the world is facing an ever-increasing array of sustainability issues. What does this all mean for education and more specifically the changing context for quality in education? The UK government would like every education institution to be more sustainable which in practice means placing greater emphasis on integrating high standards of achievement with more sustainable consumption behaviour along with the goals of environmental awareness, healthy living, citizenship and community engagement and involvement. Not an easy task for all those teachers on whose shoulders this responsibility falls.

The link between quality and sustainable development is as yet an under-researched area of educational development. And yet most commentators suggest that 'there can be few more pressing and critical goals for the future of human kind than to ensure *steady improvement* in the *quality of life* for this and future generations in a way that *respects* our common heritage – the planet on which we live.' (UNESCO, 2006, 9) The words in italics emphasise the quality dimensions of sustainable development which fall broadly into three categories:

1. Improve performance in respect of consumption and resource use
2. Improve qualitative features of the way we live e.g. better relationships, community cohesion, etc
3. An ethical dimension of quality relating to the way we take responsibility for our actions in respecting the life support systems of our planet.

The link between quality and sustainable development is probably best exemplified in the following quote:

> 'Human relationships based on naked self interest (greed, envy or lust for power, for example) maintain inequitable distribution of wealth, generate conflict and lead to scant regard for the future availability of natural resources.' (UNESCO, 2006, 15)

An education system which mirrors these values is unlikely to provide a quality education. Indeed a quality education should facilitate and promote human relationships characterised by justice, peace and negotiated mutual interests which lead to greater equity, respect and understanding. It is these qualities which underpin both sustainable development and a quality education. Or in the words of the House of Commons Environmental Audit Committee, education for sustainable development (ESD) is 'consistent with what many would consider a good all-round education' (House of Commons Environmental Audit Committee, 10).

This has a wider international resonance in the context of the OECD's key competencies which define what outcomes a quality education should deliver. These are broadly categorized as follows:

- A set of tools to interact effectively with the environment

[1] See www.ofsted.gov.uk/publications/070173

- A set of tools to enable individuals to engage with others in an increasingly interdependent world
- A set of tools to enable individuals to take responsibility for managing their own lives within a broader social context. (OECD, 2005, 5)

These are set in the wider framework of social justice, human rights and sustainable development (OECD, 2002, 9). The UN Decade for Education for Sustainable Development (2005-2014) argues that education embracing sustainable development must share the characteristics of any high quality learning experience but emphasises that an additional criterion must be that the process of learning and teaching model the values of sustainable development. These include:

- Respect for the dignity and human rights of people throughout the world and a commitment to social and economic justice for all
- Respect for the human rights of future generations and a commitment to intergenerational responsibility
- Respect and care for the great community of life in all its diversity which involves the protection and restoration of the earth's eco systems
- Respect for cultural diversity and a commitment to build locally and globally a culture of tolerance, non-violence and peace. (UNESCO, 2006, 16)

Few would disagree with these guiding principles but how these are interpreted and implemented in teaching and learning and whether this leads to higher quality education is more difficult to specify.

QUALITY AND SUSTAINABLE DEVELOPMENT

Quality is an elusive concept. This is largely because quality is used in many different contexts and its meaning changes accordingly. It is also influenced by those involved and hence will be interpreted in many different ways. Quality is also identified most often with a process called quality assurance and hence what matters are the outcomes, which can be widely varying dependent on the context. A further cause for confusion is that quality within education and other service delivery organisations is inextricably linked with shifts in politics and policies, and what was meant yesterday does not match today's meaning.

There is a more fundamental problem with the way the discussion about quality entered the educational discourse. The whole notion of quality control and of quality management was borne in manufacturing and industry. Concepts like TQM (Total Quality Management), the ISO standards and later on EQMS (European Quality Management System) have fundamentally shaped the way quality is conceptualized, analyzed and measured, also in education, even though production processes (for which these concepts where developed) and interactions in an educational setting have very little in common. In a manufacturing process the producer has total control over the production process from the design phase, through prototyping, production and marketing to sales. In education and in every service industry, this is not the case. From very early on, the recipients of the service (in our case pupils and students) are an active part of the 'production' process. In other words, the quality of an educational endeavor is not just dependent on the quality of the input provided by the teacher, but equally so by the quality of the input or engagement of the learner. The quality of the final outcome is therefore dependent on many factors and on a dynamic social interaction between various players, which means that it is very difficult to measure, to standardize and to predict.

Similarly sustainable development is difficult to define in a clear and unambiguous way. At one count there were over 200 definitions (Dawe *et al,2005.*). The most commonly used is the Bruntland definition which characterises Sustainable Development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 43).

The following quotation reflects the importance of the process to ever greater sustainability, rather than the need for a clear cut definition:

> 'Sustainability is an ideal end-state. Like democracy, it is a lofty goal whose perfect realization eludes us. For this reason, there will always be competing definitions of sustainability. We know these definitions will always include the well-being of people, nature, our economy and our social institutions, working together effectively over the long term. But as the process of attempting to achieve sustainability will continuously reveal new challenges and questions – pushing back the horizons, as it were – a definitive definition is impossible. Any indicator framework, therefore, needs to be flexible and adaptable to those changing definitions. It needs to grow as our understanding grows, while continuing to serve its purpose as a simplifier and guide to complexity. It needs to maintain a trail of continuity from year to year and decade to decade. Most important, it needs to speak to people in ways understandable both to the rational mind and to the intuition.' (AtKisson)

The complexity associated with both concepts have made theoretical and research progress difficult. Indeed the search for universal definitions of both quality and sustainable development is likely to be unsuccessful. Rather the challenge is to develop models and definitions which are appropriate to the temporal and situational context in which they function. By choosing pertinent definitions this will then guide the development of relevant conceptual frameworks as well as measurement protocols which can help explore their validity and the necessary trade offs in accepting one definition over others (Reeves and Bednar).

In spite of this if quality assurance and sustainable development are positioned within the context of performance management then the synergies become much clearer. Put very simply, performance management is taking action to make outcomes for learners better than they would otherwise be. Put simply, sustainable development is about improving the lives of people whilst living within environment limits. A central feature of sustainable development is the imperative to plan for the longer term as well as the need to consider the wider impacts of actions to deliver social, environmental and economic improvements in a joined up way. However, at present, a short term culture exists in order to meet the objectives of the next inspection or quality audit and hence performance management takes a more limited perspective.

CURRENT POLICY AND PRACTICE

There is currently no tangible policy link between quality and sustainable development. The policy remit for education for sustainable development was established in 2003 with the publication of a sustainable development action plan for learning and skills (DfES). This said very little about quality, except stressing the objective that 'all learners will develop the skills, knowledge and value base to be more active citizens in creating a more sustainable society'.

Elsewhere in this seminal document there is an emphasis on 'identifying and disseminating models of good practice'. But with little context on how the identification and dissemination process might work in practice. Since the publication of the SD action plan there has been a flurry of individual strategies and action plans from all sectors of the UK education system (UNESCO, 2008). However, there has been relatively little focus on an integrated approach to quality and education for sustainable development. Perhaps the most significant contribution has been made by the Office for Standards in Education(OFSTED) in two reports (2003 and 2008). The first 'Taking the first step forward…Towards an education for sustainable development. Good practice in primary and secondary schools' sets out a methodology for inspection and a checklist for school self-evaluation.

The inspection methodology included the following key themes

- **'Management** – focusing on the school mission statement; ESD policy statement; senior management involvement and support; references in the school development plan; allocation of resources; role of the governing body; guidance on implementation into the curriculum; relevant professional development; ESD audit; monitoring of ESD; the sustainability of ESD projects

- **Curriculum** – focusing on planning; inclusion and identification within current schemes of work and lesson planning; evidence of cross-curricular mapping

- **Teaching** – focusing on positive role models; use of local case studies; engaging local issues; links with, and use of, ESD associations; use of topicality; active learning; exploring issues leading to action on behalf of pupils; evidence in displays of work, for example, letters to decision makers; global links; field visits

- **Learning** – focusing on independent styles of learning; children developing their own reasoned points of view; pupils as active citizens within the classroom, school and community; active participation in reducing waste; active decision-making

- **Decision-making** – focusing on active involvement in a school or eco-council; examples of whole school participation and co-operation; playground committee; active environmental group; networking and community involvement; fundraising; feedback mechanisms for students to talk about school issues; pupil-parent-teacher working groups

- **Specific projects** – focusing on details of specific initiatives that the school may be involved in; links with NGOs or other areas of funding/support; details of each project context, funding, success indicators

- **General environmental indicators** – focusing on an eco-code; waste minimisation and recycling schemes managed by pupils; incentives and schemes in place for staff and pupils, e.g. to travel by means other than by car

- **Purchasing** – focusing on recycled paper; fair trade products; fresh food on offer; local produce sourcing policy; environmentally friendly purchasing throughout the school; energy efficiency measures in place; pupils' involvement in purchasing policy

- **Grounds and learning environment** – focusing on the use of school grounds and facilities; wildlife garden; use and upkeep of green space; nature set-aside; recycling facilities; use of school grounds for teaching and enhancing the taught curriculum; diversification of school buildings and grounds outside school hours, for example for community education.' (OFSTED, 2003, 20-21)

The checklist for school self-evaluation set out below provides a comprehensive quality assurance model not only for schools but for other educational institutions.

1. 'Could the school promote a culture and ethos which values the development, knowledge, attitudes and skills in pupils to enable them to participate individually and collectively to improve the quality of life in a sustainable way?
2. Has the school produced a policy statement for ESD which sets out the aims, priorities and targets for promoting ESD as a whole-school initiative, and identified strategies to promote and raise the profile of ESD within the school and the wider school community? Has it co-ordinated and monitored ESD initiatives and activities throughout the school to ensure a consistency of approach?
3. Is there a programme of staff development in place to raise awareness of ESD and develop teachers' competency and skills?
4. Have subject leaders identified opportunities within their schemes of work to enable ESD to be delivered and reinforced through the curriculum? Does the teaching approach promote active learning to develop pupils' understanding of sustainable development?
5. Does the school develop active and responsible citizenship and stewardship through pupils' involvement in active decision-making through a school council or eco-committee?
6. What links has the school established to support and develop a global and international dimension within the curriculum?
7. How does the school involve, and make use of, the wider school community to enrich learning and pupils' personal and social development including the effective use of business, local authorities, non-government organisations and community groups to support their work in developing the sustainable agenda?

8. In what ways does the school respect and value diversity?
9. In what active ways is the school involved in improving performance against sustainability indicators, including waste management, fair trade and a green purchasing policy?
10. Has the school embarked on, or maintained, a programme of ground development and improvement to support learning, promote stewardship and improve the quality of life?' (OFSTED, 2003, 22)

In spite of this pioneering work on quality and sustainable development subsequent interventions by OFSTED and other quality/audit agencies have so far been limited. The impact on progress of integrating ESD as a cross-cutting theme in all sectors of education has been at best patchy, mostly linked to the sciences, geography, design, engineering and construction as well as personal, social and health education. Nevertheless there is a growing call for integrating ESD across a wider set of subject disciplines (see for example Dawe *et al.*).

Within further and higher education the picture is more uneven and limited than in schools. In large measure this is a reflection of the absence of any intervention or support by the respective quality agencies e.g. Adult Learning Inspectorate (ALI), the Quality Improvement Agency (QIA), now the Learning and Skills Improvement Service, and in higher education the Quality Assurance Agency (QAA). The Higher Education Academy (HEA) has provided limited support to further education for sustainable development in Higher Education.

DOES EDUCATION WHICH EMBRACES SUSTAINABLE DEVELOPMENT LEAD TO A QUALITY EDUCATIONAL EXPERIENCE?

Even if a school scores well against the above criteria and even if we envisage a situation where most schools and universities have integrated ESD in a meaningful way into their curricula and institutional management, we still know very little about the quality of the outcomes.

For the crucial question is: does an educational programme which integrates sustainable development lead to a quality educational experience? Are pupils exposed to ESD better able to cope with the challenges of tomorrow in a way that guarantees sustainability than pupils who are spared the treat? Are they capable in real life to play a transformative role in society or not? In other words, are they able to contribute to the quality dimensions and values set out earlier?

The empirical evidence to support such an assumption is rather thin. Some evidence from a large scale research programme into the effectiveness of environmental education indicates some change in students' environmental attitudes, knowledge and in a few cases behaviours (Rickinson, 301).

The evidence relates to a variety of both school-based and outdoor educational initiatives. Effects, however, tend to be measured in the short term, and in most cases their durability over time is unclear. Furthermore, positive effects can be partial in that change in attitudes – though not behaviour – might occur, or can be absent altogether. It is not well understood how or why particular outcomes do or do not occur, although there is some evidence to suggest that certain aspects of programmes such their authenticity at a local level and direct experience are helpful in yielding positive impacts. (Rickinson, 302)

Rickinson also highlights that 'learning outcomes can be affected by the nature of the participating students'. He cites studies which 'have found variations in outcomes in relation to students' age and level of interest in the environment (…), students' ability levels (…), and the extent to which students enjoy a programme (…).' His conclusion was that 'students can make sense of similar learning tasks in quite different ways' and that environmental education learning experiences are influenced by factors such as gender, age, socio-economic grouping, environmental interventions and media as well as schooling (Rickinson, 302-3).

There are also some indications that the connection between sustainable development and high quality outcomes might indeed exist, partly because teaching approaches used in this context include student centred, experiential, cooperative, transdisciplinary and transformative learning which are regarded by learning theory as some of the most effective ways to learn (Martin *et al,2008*

The above cited OFSTED report into schools and education for sustainable development has found that schools which engage in sustainable development display most of the following factors which are recognised to contribute to effective learning:

A whole-school commitment

A well-developed local support network, including local education authorities and/or NGOs

Effective use of the community as a learning resource by fostering links with individuals and groups in the neighbourhood

Giving pupils both individual and collective responsibility in looking after and improving their learning environments

A well-planned curriculum

Clear objectives on the part of the teachers

Active involvement of pupils in initiatives that promote sustainability (OFSTED, 2003, 3)

A more recent OFSTED survey of 41 primary and secondary schools assessed the extent to which schools teach pupils about sustainability. In the majority of schools visited there was limited coverage of sustainability. Where it occurred it tended to be piecemeal and uncoordinated and focussed mainly on extra-curricular activities and events rather than as an integral part of the curriculum.

In individual lessons the teaching was often good and sometimes outstanding, they were stimulating and students took an active part in improving the sustainability of the school and the wider community. However, in the majority of schools the approach to sustainable development through National Curriculum subjects was inconsistent, uncoordinated and its impact tended to be short-lived and limited to small groups of pupils. The conclusion here appears to suggest that when a school takes a rigorous approach to integrating sustainable development across the curriculum then the quality of the educational experience is high, leading to changes in the school and the wider community. (OFSTED, 2008, 4-5)

FUTURE OPPORTUNITIES AND CHALLENGES

It seems to us axiomatic that for education which embraces sustainable development to become mainstream it has to be recognised as matching and even exceeding the existing quality criteria which all stakeholders recognise and value as good practice in teaching and learning. Hence the criteria for good practice need to be made more explicit in all forms of communication. However, this is where a major challenge and barrier exists because there is no universal agreement on what constitutes good practice in education for sustainable development (nor is there a sufficient catalogue of good practice in the public domain). There are two distinct processes which need further elaboration: first, the process of identifying good practice and second, the process of sharing and transferring good practice. However, at a national level there has been little research into both processes. Recent research in further education indicates that simply raising awareness of good practice through publications, web sites and conferences is insufficient to change practice (Cox,2007). This report advocates an inclusive engagement of all staff in the sharing process with support to adapt their teaching and learning practices to their own needs and within the context of their own organisation. Some of the issues identified by Cox include:

- typically those providers identified as having good practice view the transfer process as the responsibility of the receivers
- the absence of any incentives for sharing including uncertainty about cost benefit to those engaged
- the short comings of methodologies for assessing impact
- insufficient understanding of the changes necessary for achieving good practice transfer at both organisational and practitioner levels

The report also emphasises a number of critical factors for successful transfer. These include:

- confidence in the source of the practice
- reciprocity and parity of status between the participants
- sharing as an active learning process
- how the process is led, managed and resourced
- impact assessment (Cox, 4-5).

Another significant issue in taking quality and sustainable development in the curriculum forward is how we currently conceptualise quality in our education systems. As a broad generalisation our concept of quality is based on a relatively limited stakeholder interest, largely focusing on economic outcomes rather than the wider dimensions of sustainable development. This concern is best exemplified in a recent discussion paper on quality and higher education (nef). It argues that a narrow focus and prioritisation on the economic role and purpose of higher education 'restricts how quality is defined and understood' and hence practiced. Learners are identified largely but not exclusively as future workers and hence quality is specified in terms of non-completion rates, graduate employment statistics and graduate earnings. In addition, quality assurance procedures are characterised by approaches which meet minimum standards, ensure consistency and value for money. The report presents a convincing argument for redefining quality to 'capture higher education's transformative role for individuals and for the wider economy, environment and society'. We agree with the conclusion that current approaches to quality are 'conditioning learners to become part of a market driven system'.

> 'This commercialisation of higher education serves a bigger purpose, though. It softens students up for the rigours of globalisation. By creating a market, young people are encouraged to think and behave like rational economic man. They become 'human capital', calculating the rate of return on their university investment. A degree becomes a share certificate. Commercialisation conditions students to expect no help from others, or society, and therefore never to provide help in return. Debt and economic conditioning discourages graduates from going into lower-paid caring jobs - and instead into the City, where the real 'value' is. It fashions a Britain that competes rather than cares.' (N. Lawson quoted in nef, 10)

The report also offers a valuable ESD quality framework which could guide our thinking and practice. It is based on seven categories which every learner should know:

1. In depth knowledge of a favourite subject
2. How to apply knowledge
3. What makes a good life
4. How others think
5. How change happens
6. The dynamics of power and influence
7. Global interdependence (nef, 13-15)

Education which embraces sustainable development is a messy business, it is not precise at a conceptual level and requires continuing reflection and critical analysis both by policy makers and by practitioners. Hence a quality framework which embraces ESD cannot be narrowly prescriptive. Yet much of the policy discourse over the past 30 years has been on preparing young people for the world of work and how nations compete in the global economy. This paper argues, as have others before us, that alternative ends are needed which embrace the principles and values of sustainable development. And through which we can progress new forms of learning which enable practitioners and learners to explore a more transformative educational experience.

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Chapter 18

EVALUATING CURRICULUM REFORM IN TURKISH SECONDARY EDUCATION

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ABSTRACT

This study aims to explore the curriculum reform initiated in 2005 in the secondary level education in Turkey with special reference to its impact upon *Anatolian high schools,* highly competitive schools in Turkish education. A large-scale survey was administered to 170 teachers and 851 students in order to determine their perceptions of this recent curriculum implementation. In the analysis of the survey questionnaire, both descriptive analysis and content analysis were employed. Findings indicated that despite disagreements in the perceptions of teachers and students on some issues, both groups of participants had a favorable opinion on many aspects of the curriculum innovation. It is suggested that the findings be evaluated within the overall framework of the current education system.

Keywords: Anatolian high schools, English language preparatory program, secondary level education

INTRODUCTION

With the effect of globalization and the spread of English as the *lingua franca* of international communication, Turkey, like many countries in the world, has started to question its education system and engaged in a large-scale curriculum reform in recent years.

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Following the major curriculum innovation in 1997, which aimed at promoting English language teaching (ELT) at the primary level education and re-structuring the higher education, it was not until 2005 that another major curriculum re-structuring was undertaken at the secondary level education. One of the major impacts of the 1997 curriculum innovation was to extend the duration of the primary education into eight years by combining the five-year primary and three-year secondary education into a single stream, and to lower the age at which children start learning English at a younger age (9) (see Kırkgöz, 2005; 2007 for details).

In Turkish education system, the English language is a compulsory foreign language in the school curriculum. Accordingly, English is included in the curriculum of all secondary schools offering three-year education. However, schools such as Anatolian high schools, private schools and super high schools hold a different status in that they offer one-year intensive *İngilizce hazirlik sinifi* - English language preparatory program (ELPP) prior to the three-year education. Owing to the one-year English education, students graduating from these schools achieve a higher level of English language proficiency compared to other schools (Kırkgöz, 2005).

Anatolian high schools are highly competitive schools and they appear under such various names as Anatolian science high schools and Anatolian teacher education high schools. Entrance to these schools and private schools is achieved through a standardized examination administered by a central examination board. To be accepted into super high schools, however, students are required to score an average of 4.0 out of 5.0, the top grade (Kırkgöz, 2007).

The 2005 curriculum innovation initiated by the Turkish Ministry of National Education (MNE) aimed to restructure the secondary education. The first impact of this reform was an increase in the duration of all secondary schools from the previous three to four years. A further consequence of the reform was to abolish one-year ELPP from all types of Anatolian high schools, super high schools and most private schools. Following the restructuring process, the English language curriculum taught during one-year ELPP, was spread across the four-year education. A final impact of the 2005 curriculum re-structuring was to merge all super high schools and different types of Anatolian high schools under a single program - Anatolian high schools - with a view to standardization in the education system. This curriculum innovation started to be implemented incrementally following the 2005-2006 school year (Kırkgöz, 2007; 2009).

The underlying motivation for the 2005 curriculum change was to upgrade the Turkish education system to that of the countries of the European Union (EU), of which Turkey is aiming to become a member, and to establish harmony between the Turkish education system and those of EU countries.

A review of the literature finds little or no studies on assessing the impact of this recent curriculum reform in the years following the implementation of this re-structuring. This study aims at fulfilling this need through an exploratory study to elicit perceptions of teachers who have already worked in one of the aforementioned schools, and students who have already experienced one-year intensive ELPP during their secondary education, concerning the recent curriculum innovation in Anatolian high schools.

METHODS

Participants in the Study

170 teachers, 89 female (52.4%) and 81 male (47.6%) who had already taught in an Anatolian high school or a super high school with teaching experience between 5-16 years, and 851 students who had attended to such schools in their secondary education but are currently attending to a university participated in the study. Of the 851 students 414 were male (48.6%) and 437 (51.4%) female.

A survey questionnaire was used as the primary source of data in the academic year 2008-2009. Two sets of questionnaires were designed; one for the students and the other for the teachers. The design of the questionnaire was based on the aim of the study to identify participants' views concerning the recent curriculum restructuring and abolishing one-year ELPP. Expert opinion from five faculty members was received for face validity, and the instrument was pilot tested with 20 teachers and 90 students. The questionnaire comprised three sections: Section one of the questionnaire asked participants to provide demographic information about themselves (age, gender, etc.) The second section included nine statements towards re-structuring Anatolian high schools, requiring respondents to rate their responses on a five-point Likert scale, (1 represented 'strongly disagree', and 5'strongly agree'). Section three of the questionnaire included two open-ended questions to obtain more insights into accounts of teachers' and students' experiences concerning the recent curriculum innovation.

Descriptive statistics were employed in analyzing the data except the responses given to open-ended questions, which were analyzed qualitatively through a process of pattern-coding (Miles and Huberman, 1994) to identify the recurrent themes.

Findings

Students' responses

As Table 1 demonstrates, 63% of the students disagreed (34% strongly disagree - 29% disagree) to the first statement that "taking one-year preparation class of English in secondary school was a waste of time". The students' response to the second statement "after one-year preparation class of English, the students learned English sufficiently" varied between 30% of the students expressing their agreement, but 24% disagreement. To the third statement asking whether a "four-year period of secondary school education would be more beneficial for the students in learning the English language", the responses ranged between 27% agree but 24% undecided. To statement four aiming to find out "if the students had been given the right to choose, whether they would have preferred to have started with the first year of secondary school instead of receiving preparation class", almost half the respondents (52%) expressed their disagreement (26% disagree - 26% strongly disagree), suggesting that only half the students favored ELPP. 54% of the students expressed their agreement (30% agree and 24% strongly agree) to statement five, which aimed to explore "the extent of students' satisfaction about the quality of education they received during the preparation year". The students' response to statement six "even if I had the chance to be optionally exempted from preparation class in high school, I would still have preferred to have preparation class" revealed a low level of agreement with only 46% of agreement (25.4% agree, 20.3% strongly agree).

The students' degree of adaptation to content courses after receiving one-year preparation class was explored through the statement: "The fact that I had an intensive period of English education during preparation class caused me not to be able to adapt to the other courses except English, such as mathematics, geography". Students were divided in their opinion with 26% them disagreed while 23% agreed. They (61.4%) expressed their disagreement (32.4% disagree and 29% strongly disagree) to the next statement that "I did not pay enough attention to the courses of preparation class because of the fact that my grades of preparation class were not going to affect the grades of my diploma, suggesting that students paid attention to English language classes. Most students (64.4%) agreed (35.1% strongly agree and 29.3% agree) to the last statement that "the English education which the students received in preparation class contributed to their present university education offered either in the medium of English or Turkish language".

Table 1. Students' Responses

Statements	Strongly Disagree		Agree		Undecided		Disagree		Strongly Agree	
	No.	%	No.	%	No.	%	No.	%	No.	%
1. I took one-year preparation class of English in high school and I consider it as a waste of time.	144	16.9	96	11.3	76	8.9	245	28.8	290	34.1
2. After one-year preparation class of English, I learned English sufficiently.	122	14.3	254	29.8	161	18.9	207	23.3	107	12.6
3. I believe that a four-year period of high school education would be more beneficial for the students in learning English.	185	21.7	230	27.0	202	23.7	121	14.2	113	13.3
4. If I had been given the right to choose, I would have preferred to have started with the first year of high school instead of receiving preparation class.	176	20.7	126	14.8	108	12.7	224	26.3	217	25.5
5. During the preparation year, I was glad about the quality of English language education.	203	23.9	252	29.6	153	18.0	145	17.0	98	11.5
6. Even if I had the chance to be optionally exempted from preparation class in high school, I would still have preferred to have preparation class.	173	20.3	216	25.4	139	16.3	151	17.7	172	20.2
7. The fact that I had an intensive period of English education during preparation class caused me not to be able to adapt to the other courses except English, such as mathematics, geography.	158	18.6	199	23.4	106	12.5	224	26.3	164	19.3
8. I did not heed the courses of preparation class because of the fact that my grades of preparation class were not going to affect the grades of my diploma.	113	13.3	146	17.2	69	8.1	276	32.4	247	29.0
9. The English Education I had in preparation class contributed to the education (either in English or in Turkish) I have had at university.	299	35.1	249	29.3	80	9.4	114	13.4	109	12.8

Through the two open-ended questions, students were given an opportunity to express their perception of ELPP, in retrospect. The first open-ended question asked what the advantages and disadvantages, if any, of having an ELPP in secondary school were for the students. Analysis of this question revealed the emergence of six categories; three advantages and three disadvantages.

The first advantage, as perceived by 70% of the students, was that ELPP *formed a foundation of English*. Next, 19% of the students thought that ELPP *contributed to university education*. The final benefit was that after a very competitive entrance examination, which they had to take in order to get accepted into Anatolian schools, studying one-year ELPP enabled them to *adapt into a new school environment,* as reported by 11% of the students.

Besides these advantages, several disadvantages were identified. First, 47% of the students thought that receiving one-year ELPP was a *waste of time* in their education. Next, 27% of the students reported that one-year exposure to only English caused an intervention in their education continuum; as a result, they had *a feeling of being distanced from content courses,* e.g., mathematics, thus lowering their success in these courses, and they had difficulty in adapting to such courses, the following years. Finally, 26% of the students complained of *inadequate education* they received. Students stated that they perceived noticeable improvement in their knowledge of English; yet, this improvement was mainly in grammar, lacking in productive skills, e.g., speaking and writing.

The second question asked students' perceptions whether "abolishing preparation class is a disadvantage for the future language majors while it is an advantage for the non-language majors, i.e., engineering, medicine". Most students (40%) reported that due to the importance of the English language, receiving one-year ELPP was an advantage for students regardless of their future major; 28% of the students thought that ELPP favored mainly language majors rather than non-language majors; and that even for language majors ELPP was considered unnecessary due to disadvantages mentioned earlier.

Through the questionnaire, the students offered several suggestions. First, 32% of the students expressed their support for abolishing ELPP, and spreading English across the four-year secondary education curriculum. They were of the opinion that rather than receiving one-year ELPP prior to the secondary school, they would rather have learned English along the years. 14 students suggested that ELPP would have been optional, and content lessons be added to the curriculum.

Teachers' responses

As Table 2 illustrates, teachers (73%) reached an agreement on the first statement that "taking one-year preparation class of English in secondary school was not a waste of time for the students (27.6% strongly disagree – 45.3% disagree). The second statement enquiring whether after one-year preparation class of English, students learned English sufficiently, teachers' views differed with 35% of the teachers agreed, but 22% disagreed. Teachers (61%) expressed their disagreement (30% strongly disagree and 31.2% disagree) to the third statement eliciting their views whether "English is now taught better and more effectively through a four-year period of secondary school education", suggesting that the standard of teaching English in Anatolian high schools is falling. The statement four aimed to determine whether the students' level of English had risen after the curriculum reform, 59% of the responses expressed their disagreement (29% disagree - 30% strongly disagree). Concerning teachers' perceptions to the next statement asking whether an increase in the number of

Anatolian high schools lowered the quality of ELT in these schools, teachers expressed different views with 29% of them agreed but 21% thought that the quality of education was not lowered by expressing their disagreement. Teachers' opinion whether after merging super high schools with Anatolian high schools the success of English has increased, responses ranged between 31% of the teachers disagreed and 24% were undecided. Most teachers (60%) agreed (29% agree and 31% strongly agree) that "an intensive period of English education during preparation class caused students not to be able to adapt to content courses. Also, 64% of the teachers did not think that "the teaching hours of English in the new system is as effective as the previous one", as indicated by their responses (34% strongly disagree - 32% disagree). The final statement asking whether abolishing ELPP has been a disadvantage for the students, 69% of the teachers expressed their agreement (46% strongly agree- 23% agree).

Table 2 Teachers' Responses

Statements	Strongly Disagree		Agree		Undecided		Disagree		Strongly Agree	
	No.	%	No.	%	No.	%	No.	%	No.	%
1. One-year preparation class of English in secondary school was a waste of time.	16	9.4	20	11.8	10	5.9	47	27.6	77	45.3
2. After one-year preparation class of English, students are sufficiently equipped with knowledge of English.	29	17.1	60	35.3	23	13.5	38	22.4	20	11.8
3. The English language is taught more effectively in the current four-year period of secondary school education.	11	6.5	26	15.3	29	17.1	53	31.2	51	30.0
4. Students' level of English has risen after the curriculum reform.	11	6.5	43	20.0	25	14.7	49	28.8	51	30
5. Increase in the number of Anatolian high schools lowered the level of English in these schools	32	18.8	50	29.4	31	18.2	35	20.6	22	12.9
6. The quality of English language teaching has increased after super high schools merged with Anatolian high schools	18	10.6	29	17.1	40	23.5	52	30.6	31	18.2
7. The fact that students received an intensive period of English education during preparation class caused them not to be able to adapt to the other courses except English, such as mathematics, geography.	18	10.6	31	18.2	18	10.6	50	29.4	53	31.2
8. The teaching hours in the current curriculum are as effective as the previous one.	3	1.8	31	18.2	24	14.1	54	31.8	58	34.1
9. Abolishing English language preparation class is a major disadvantage for the students.	78	45.9	39	22.9	11	6.5	28	16.5	14	8.2

On the teachers' questionnaire, the first open-ended question asked teachers their perceptions of what alternative could have been offered instead of abolishing ELPP. Teachers (61.4%) suggested that some content courses could have been added to ELPP along with teaching English language so as to lower the distancing effect that the students experienced towards such courses in the following years. Another suggestion offered by 34% of the teachers was rather than abolishing ELPP, the quality of teaching could have been strengthened by offering teacher development opportunities to practicing teachers. Finally, eight teachers, as also suggested by the students, pointed out that ELPP could have been offered *optional*.

Many teachers (*n*=65) welcomed the changes introduced by the new curriculum innovation for several reasons: First, they stated that the learning of a foreign language required a process, and to achieve a permanent knowledge of English, an intensive teaching (24 hours weekly) focusing merely on one lesson rendered the English language quite boring for the students, and also lowered students' interest in other lessons.

Curriculum reform was perceived necessary by many teachers for several reasons: (*n=36*) First, it was thought to be more contemporary in its approach and the underlying philosophy. Now that the students learn English across four years, they learn it more effectively with higher interest and motivation. Next, standardization across Anatolian high schools and super high schools was being achieved. Teachers also reported that the distancing effect caused by one-year exposure to *only English* was largely overcome by the new system, and that the students are now able to keep up with content courses along with learning English. Finally, students, particularly non-language majors, do not waste one year in their education life.

Concerning the new curriculum, teachers (*n*=50) stated that after the restructuring process, the curriculum is able to meet students' requirements. Besides, they offered several suggestions that would aid the future direction of the present curriculum. First, they suggested an increase in the number of teaching hours in the secondary school curriculum and better teaching materials. Like students, teachers agreed that an increase in the quality of education in ELT starting from primary level education onwards would benefit not only the language majors but also non-language majors in the long-run.

The second open-ended question asked teachers to explain what impact the new system had on the teachers, and positive and negative aspects regarding the teaching of English. Teachers (*n*=36) considered the new curriculum as an innovation for themselves; an opportunity for professional development to offer more effective education. In addition, teachers admitted that they were going through a period of transition in being adjusted to curricular changes. During this transition period, those who were previously teaching only one or two class of students, are now having to teach different class of students, this preventing them to pay individualized attention to each student. While some teachers (*n*=30) stated that due to a decrease in their teaching load, they are now able to provide a better quality education, others (*n*=11) pointed out that this change in teachers' schedule affected their motivation.

Having been subjected to a different curriculum might have made some teachers less appreciating of the new system. 64 teachers thought that students do not attain the same level of language proficiency compared with former students upon graduation. In this respect, they were concerned that Anatolian high schools were losing their traditional status.

DISCUSSION

Survey findings reveal the emergence of several issues. It has been found that while ELPP offered students several advantages as constituting *a foundation of English, contributing to students' current university education*, and *making the transition to a new school environment easier*, the students in the open-ended section of the survey, also reported several disadvantages. Many students thought that receiving one-year ELPP has been a *waste of time*, an intervention in their education continuum; after receiving ELPP they experienced *difficulties in adapting to non-English content courses*, and that students complained of *inadequate education* they received.

Findings also illustrate that teachers and students agree on several statements. For instance, after an intensive period of English education during preparation class, students experienced difficulties in adapting to content courses was agreed by teachers and students. Furthermore, after one-year ELPP, the students learned English sufficiently was agreed only by a low majority of the teachers and students, suggesting that the previous curriculum was not highly satisfactory in providing quality education.

Teachers' and students' perceptions differed on other issues. While the students thought that the four-year secondary school education would be more beneficial for the students in learning English, on a parallel statement, teachers disagreed that English is now taught more effectively through a four-year period of secondary school education.

Regarding the new curriculum, majority of the students and over half the teachers expressed their support for abolishing ELPP owing to several unfavorable effects caused by the practice of ELPP, and that spreading English across the four-year secondary education curriculum was perceived to be necessary in providing a better quality ELT. Both groups of participants also agreed that the implementation of the present ELT curriculum in which English language teaching starts at an early age from the primary school and continues till higher education, would benefit not only the language majors but also non-language majors, in the long-run. On the other hand, some teachers were concerned that the students' level of English had not risen after the curriculum reform; the teaching hours of English in the new system was not perceived as effective as the previous one; and that abolishing ELPP was considered to be a disadvantage for the students.

One important issue emerging from this study is the need to provide teachers professional support they need to ensure more effective implementation of the new curriculum. Teachers, as key players in implementing curriculum, need to be supported to achieve effective implementation of change by majority of the teachers (Carless, 1997; Kırkgöz, 2007, 2009). In order to promote the quality of foreign language education, teachers need to be supported to help them make the transition and to facilitate their adjustment to the new system. Additionally, the current ELT curriculum in the secondary schools needs to be revised in terms of the teaching materials and the teaching hours to strengthen the content of the curriculum.

CONCLUSION

This study was conducted four years after enactment of the 2005 curriculum innovation. In evaluating the present research findings, one needs to consider education as a continuum from primary to secondary education. The total time frame with major restructuring efforts to take its full effect is said to be lengthy taking five to ten years (Fullan, 1993). Therefore, it takes time for the present reform to achieve its intended aim and for the changes introduced by the curriculum innovation to take roots to grow, and be more effectively implemented by majority of the teachers. In the long run, when the Turkish education system has adjusted itself to this new implementation, it is more likely that the teaching and learning of English, as a foreign language, in Anatolian High schools will become a more fruitful experience, and that the advantages accrued by the new curriculum will make up for any possible drawbacks, as identified in the present study.

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Chapter 19

EDUCATING THE WHOLE CHILD: THE ROLE OF SOCIAL AND EMOTIONAL DEVELOPMENT IN ACHIEVEMENT AND SCHOOL SUCCESS

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Historically, early childhood education focuses on developing knowledge in literacy and mathematics to prepare children for skills they need to become informed and productive members of society. Although few will argue against the inclusion of literacy and mathematics skills in school curriculum, social and emotional competencies are increasingly being recognized and valued as essential for children's school and life successes (Duncan et al., 2007; Payton et al., 2008; Raver & Knitzer, 2002). In the current era of standards-based accountability, it is understandable why curricula often emphasize academic (e.g., literacy and mathematics) over "nonacademic" (e.g., social-emotional and self-regulatory) skills. However, the distinction between academic and nonacademic learning may be grounded in tradition rather than evidence-based research. In fact, emerging evidence from developmental and educational research indicates that social-emotional, self-regulatory, and academic competencies are often intertwined and complementary to the development of one another (e.g., Blair & Razza, 2007; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003; Liew, McTigue, Barrois, & Hughes, 2008; McClelland et al., 2007). In order to nurture motivated and competent learners, curriculum and teaching practices need to reflect and work with the synchronous development of the whole child.

Curriculum development has become increasingly sensitive and responsive to the fact that children enter formal school from diverse backgrounds and with varying levels of skills (Winsler et al., 2008). *School readiness* is a broad concept which makes it difficult to reach a consensus on its definition. However, there appears to be little disagreement that school readiness is essential before entering school to ensure that students, particularly those from low-income or ethnic minority backgrounds, are equipped with the necessary readiness for learning and school (Kagan, 1992). School readiness is comprised of multiple domains of capacities and skills that have been classified into *readiness to learn* and *readiness for school*.

Readiness to learn is viewed as the "level of development at which an individual (of any age) is ready to undertake the learning of specific materials," and refers to the age at which the average child has the specified capacity to start learning (Kagan, 1990, p. 273). In contrast, readiness for school specifies cognitive and linguistic skills (e.g., being able to draw a square or identify shapes and colors) with less emphasis on developmental readiness. When learners enter schools without adequate readiness for learning or for school, any early (even if small) differences often accumulate to result in meaningful or large differences over time in students' learning and achievement (Ramey & Ramey, 2004). Although there are disagreements regarding both the specific skills that are required for successful transition into formal schooling (e.g., readiness for school) and the age by which such skills should be developed (e.g., readiness to learn), emerging evidence indicates that abilities to manage emotion, attention, and behavior and to form positive peer relationships are prerequisites for school readiness and academic success (Blair, 2002; Denham, 2006; Payton et al., 2008; Raver & Knitzer, 2002). Accordingly, curriculum at the preschool level should attend to such social and emotional skills in order to fully develop readiness for school and learning.

CHILD TEMPERAMENT AND SCHOOL READINESS

Children's social-emotional and self-regulatory skills facilitate school readiness (Bierman et al., 2008; Denham, 2006). In the next section, we will review relevant empirical research that explicates the linkages between individual differences in social-emotional or self-regulatory skills and school success. In the study of emotion, attention, and self-regulation in early and middle childhood, child temperament has been linked to individual differences in abilities to manage emotions and behaviors as well as social and peer competencies (e.g., Blair, Denham, Kochanoff, & Whipple, 2004; Eisenberg et al., 2005; Liew, Eisenberg, & Reiser, 2004; Rothbart & Jones, 1998). Temperament has been viewed as the basic emotional, behavioral, and self-regulatory building block that provides the developmental foundations for complex behaviors, personality, adaptation, and adjustment (Rothbart & Bates, 2006). Temperament can be defined as a person's emotional, attentional, and behavioral styles that appear early in life and remain relatively stable across the lifespan, but are shaped by experience (Derryberry & Rothbart, 1997). In particular, the findings that temperament is not entirely fixed in nature, but has dynamic qualities which are influenced by the environment, are highly relevant to curriculum development.

Of particular relevance to school success is self-regulation. Self-regulation is part of the temperament system, and self-regulatory processes have been distinguished as those that are relatively under a person's volitional control, in contrast to those that are reactive and involuntary (Derryberry & Rothbart, 1997). It is important to note that volitional and reactive processes often operate simultaneously, and it is often challenging to definitively separate one from the other (Derryberry & Rothbart). One important aspect of temperamental self-regulation is effortful control. Effortful control refers to the volitional aspect of self-regulation and is defined as the ability to voluntarily inhibit a dominant response to activate a subdominant response (Rothbart & Bates, 2006). Effortful control is linked with executive attention and executive functioning (Sheese, Rothbart, Posner, White, & Fraundorf, 2008) and has been used to describe the volitional or willful aspect of self-regulatory processes. For example, children would demonstrate effortful control by doing something they need to do over something they prefer to do, such as studying for an exam rather than going outside to play. As early as preschool or kindergarten, the importance of self-regulation and effortful control to school adjustment is evident (Raver & Knitzer, 2002).

THE ROLE OF EFFORTFUL CONTROL DURING EARLY SCHOOL YEARS

As children transition from preschool to kindergarten, the need for self-regulatory skills increases and continues to increase throughout schooling. In a national study of 250 kindergarten classrooms, children experienced structured or teacher-directed instruction for 43% of the school day (Rimm-Kaufmann, LaParo, Downer, & Pianta, 2005). In more highly structured and teacher-directed classroom environments, children with poor self-regulatory skills tend to have difficulties meeting school demands and are prone to experience peer rejection and conflicted relationships with teachers (Denham et al., 2003; Pianta, Steinberg, & Rollins, 1995). For example, early self-regulatory problems as manifested in aggression, impulsivity, inattention, noncompliance, or social reticence may interfere with children's availability for instructional time as well as with their development of important social skills such as peer play that contribute to learning in the preschool or kindergarten classroom.

By first grade, traditional instructor-centered classrooms require children to comply with teachers' requests and classroom rules, to work independently at their desks for extended periods, and to cope effectively with the negative emotions or frustrations that are often elicited by social and academic challenges. Generally, abilities to self-regulate are not only expected, but required, in order for children to progress and succeed from grade school into higher education. Of particular relevance to curriculum development and educational equity is that promoting self-regulatory capacities may minimize achievement disparities amongst students from disparate socioeconomic backgrounds if effortful control contributes to academic achievement independent of economic adversity (Liew et al., 2008).

EFFORTFUL CONTROL AND ACADEMIC ACHIEVEMENT

Although often observed by educators in classrooms, a growing body of empirical evidence confirms a definite linkage between effortful control and academic achievement in young school-aged children, including children from low-income and ethnic minority backgrounds (e.g., Blair & Razza, 2007; Liew et al., 2008; McClelland et al., 2007). In a study of preschoolers enrolled in Head Start programs (designed for low-income children and their families), children's abilities for effortful control contributed to their emergent mathematics and literacy skills (Blair & Razza). Similar results were found in a study with preschoolers from diverse socioeconomic backgrounds where behavioral self-regulation was significantly associated with early mathematics and literacy skills (McClelland et al.). Beyond the preschool years, evidence indicates that effortful control continues to play an important role in academic achievement throughout the elementary school years. For example, in a longitudinal study of first through third graders who were predominantly from low-income and ethnic minority families and assessed by their school district as entering first grade with below-average literacy skills, effortful control predicted literacy achievement of 2 years later (Liew et al.). In middle childhood, effortful control predicted grade point averages in a sample of 7- to 12-year-olds above the effects of grade point averages from the previous semester and teacher-student relationship quality (Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008).

EFFORTFUL CONTROL IN SCHOOL CONTEXT: A CHILD IN CLASSROOM PERSPECTIVE

Although children bring unique temperamental qualities (e.g., abilities for effortful control) into the classroom that may contribute to their learning and achievement, the learning environment, including the curriculum, plays a integral role in students' achievement and in shaping students' social and emotional strengths. One aspect of the learning environment that has been identified as important for students' achievement is the quality of teacher-student relationships. Teachers are important socializers and sources of support outside of the home environment for children, and teacher-student relationships that are positive, supportive, warm, and low in conflict are linked to students' positive school outcomes (Goodenow, 1993; Hamre & Pianta, 2005; Ladd, Birch, & Buhs, 1999; Palermo, Hanish, Martin, Fabes, & Reiser, 2007; Reddy, Rhodes, & Mulhall, 2003). A supportive teacher may play a compensatory role for children with self-regulatory difficulties by providing them an external source of motivation or regulation (Liew, Chen, & Hughes, 2009). In support of this view, evidence suggests that the link between positive teacher-student relationships and academic outcomes may especially be pronounced for students with self-regulatory difficulties (Hughes, Cavell, & Jackson, 1999; Liew et al., 2009; Pianta, Nimetz, & Bennett, 1997).

Research indicates that positive teacher-student relationships are consistently linked with increased academic motivation, positive self-concept, and achievement (Birch & Ladd, 1997; Howes, 2000; Hughes, Gleason, & Zhang, 2005; Hughes & Kwok, 2006; Palermo et al., 2007; Pianta et al., 1995; Ryan, Stiller, & Lynch, 1994). For example, kindergarteners with supportive teachers performed better than those with less supportive teachers on standardized measures of reading and mathematics skills (Graziano, Reavis, Keane, & Calkins, 2007). Preliminary evidence also suggests that positive teacher-student relationships may protect children from negative home environments (O'Connor & McCartney, 2007). In addition, Rimm-Kaufman et al. (2002) found that 15-month-olds who were classified as socially bold were more academically engaged as kindergarteners when paired with sensitive teachers than similar children with less sensitive teachers. Consistent with the view that child temperament interacts with the learning environment to influence learning or achievement, Liew et al. (2009) found that child effortful control and positive teacher-student relationships interact with one another to contribute to future child academic achievement on standardized tests of reading and mathematics. Specifically, results suggested that supportive teachers play a compensatory role for students with self-regulatory difficulties by creating a positive and low-conflict learning environment that promotes future academic achievement. In addition, child effortful control may serve as a protective factor for achievement in learning environments where students may be receiving or needing little support from the teacher (Rudasill &

Rimm-Kaufman, 2009). For students with self-regulatory difficulties, such as low effortful control, being paired with emotionally and instructionally supportive teachers was important for their future academic success (Liew et al.).

In summary, teacher-student relationships are critical in the promotion of academic and social emotional growth. A flexible curriculum that is designed to allow and encourage teachers to be responsive and adaptive to children's needs facilitates the development of strong teacher-child relationships.

FROM SCIENCE TO PRACTICE: SOCIAL EMOTIONAL LEARNING (SEL) IN SCHOOLS

As summarized in previous sections, a growing body of research shows that capacities for self-regulation and effortful control in childhood make significant contributions to concurrent and future positive school outcomes such as positive social and behavioral adjustment, achievement, and improved standardized test scores on achievement measures (e.g., Blair & Razza, 2007; Liew et al., 2008; Liew et al., 2009; McClelland et al., 2007; Payton et al., 2008; Valiente et al., 2008). Thus, it is imperative that school curriculum integrate activities that promote the development of social-emotional and self-regulatory skills with academic instruction. Particularly when educational practices emphasize high-stakes, standardized testing to assess educational accountability and student achievement, students' abilities to pay attention, inhibit their impulses, and regulate emotions or cope with stress become core skills for academic success. Resources are available to help schools identify, select, and implement social and emotional learning (SEL) programs, including Safe and Sound: An Educational Leader's Guide to Evidence-Based Social and Emotional Learning (SEL) Programs that reviewed and compared 80 programs (Collaborative for Academic, Social, and Emotional Learning, 2003). One example of such programs is the PATHS (Promoting Alternative Thinking Strategies) curriculum which has shown success in long-term improvements on children's school adjustment (Greenberg, Kam, & Kusche, 2004; Greenberg, Kusche, Cook, & Quamma, 1995).

Although Social Emotional Learning (SEL) programs have been shown to be effective in improving students' social and academic outcomes (Payton et al., 2008), their inclusion in schools has been relatively limited for multiple reasons. First, despite the fact that a number of SEL programs have been proven to be efficacious and the value of programs' benefits exceeds their costs, schools rarely adopt these programs (National Advisory Mental Health Council Workgroup on Child and Adolescent Mental Health Intervention Development and Employment, 2001; National Institute of Mental Health, 1996). Additionally, although implementation is highly predictive of program effects, the fidelity of program implementation often is poor when schools adopt SEL programs, particularly because of a lack of personnel trained in SEL approaches. Even in the best case scenarios, when programs are adopted and implemented with fidelity, programs are often not integrated with academic curricula and not continuously sustained as children transition across grades (Kam, Greenberg, & Walls, 2003).

Several factors contribute to poor implementation and sustainability of SEL programs. When programs are not integrated with academic instruction, SEL programs are often viewed by administrators and teachers as “lost instructional time” rather than as contributing to the mission of educating the whole child. Additionally, training and staff support to effectively implement the programs are often lacking. In such cases, when teachers are not engaged as active collaborators in the development and implementation of the programs and inadequate attention is paid to teacher perception of need for change, there will be limited incentive or motivation for teachers to deliver SEL programs with fidelity or continuity. Thus, sustained implementation of SEL programs often depend on both curriculum development that integrates academic and SEL objectives and the support and enthusiasm of school administrators and teachers who implement the curriculum and programs. A critical reason underlying these problems and preventing SEL programs from “traveling well” from science to practice is the belief that SEL programs are simply “things” or “products” that school districts can buy and put into classrooms with minimal impact on “nonprogram” aspects of classrooms. Because classrooms are incredibly complex and dynamic contexts, curriculum development that integrates SEL into academic programming needs to acknowledge and understand such complexities.

We believe that the power of SEL programs resides not so much in the program itself, but in how the program produces changes in teachers’ attitudes and behaviors that then translates to positive teacher-student relationships and affects children’s everyday interactions and behaviors in the classroom. As such, teachers need professional, emotional, and autonomy support in making adaptations that fit each of their classrooms and teaching philosophies, so that they “own” the knowledge and skills and apply them as part of their teaching “style” or identity (Deci & Ryan, 1985, 2000). Changed teacher behavior, which emerges in part through the implementation of SEL program, is the key to creating positive social and emotional contexts for learning. We view SEL curricula that complement academic curricula and is implemented in ways that do not diminish teacher authority, self-efficacy, and professionalism as a promising avenue in maximizing students’ learning and achievement.

In the following sections, we describe ways that the two approaches to learning can complement one another within the interconnected areas of assessment and mastery benchmarks. To illustrate how this could be done within the classroom context, we provide examples using literacy development and the assessment of such skills (see McTigue, Washburn, & Liew, 2009). We focus on assessments because we feel that what we choose to assess have implications for curriculum development.

INTEGRATING SOCIAL EMOTIONAL LEARNING INTO CURRICULUM AND ASSESSMENTS

In regards to the types of assessments used and their roles in education, there is a stark contrast between curriculum driven by primarily academic achievement objectives and by primarily human development objectives. In the following sections, we present how both the academic and social needs of the students should be considered when selecting and interpreting assessment.

Academic achievement objectives

When curriculum is driven primarily by academic achievement objectives, assessments tend to take the form of frequent and standardized testing with norm-referenced instruments. Such tests are used to gauge or document students' progress towards a pre-determined (e.g., state-wide) benchmark. Standardization is important in order to serve as a common metric for the basis for comparison. Comparisons can document student growth and compare students' performances across schools, districts, and states. Furthermore, students' test performances on standardized assessments often become the basis for determining the efficacy and funding of school programs, school systems or districts, and states.

Although standardized achievement assessments are valuable methods appropriate for large-scale summarization and comparisons (Cizek, 2001), it is important to note that they are less appropriate for use with individual students' learning and progress (Paris, Lawton, Turner, & Roth, 1991). When used with individual students, standardized tests may offer information on which students are or are not meeting set criteria or benchmarks without offering much information on how to move students towards that goal. Additionally, the heavy reliance on high-stakes, standardized tests may inadvertently endorse developmentally inappropriate educational practices in early and middle childhood (Paris et al.). In response to meeting state testing requirements that start as early as first grade, schools often feel pressured to narrow the curriculum to focus on a specific set of regimented mathematics and literacy skills. Yet, young children need time for creative, autonomous, and social play which is a form of cognitive and social-emotional learning (Bjorklund & Brown, 1998). For example, the National Association for the Education of Young Children (NAEYC) (NAEYC, 2009) Guidelines for Appropriate Curriculum and Assessment in Programs Serving Children Ages 3 Through 8 emphasizes play as an essential method of learning which simultaneously fosters cognition, self-regulation, and social competence.

Human development objectives

In contrast to a heavy reliance on high-stakes, standardized testing described above, assessments driven by human development objectives acknowledge the need for achievement while also attending to the needs to develop social-emotional skills in order to educate the whole person. Thus, achievement measures driven by human development objectives tend to encourage the use of "authentic assessments" (such as naturalistic observation that considers the learner in context) and lessen the role of standardized testing. Naturalistic observations can document both the academic performance of students and the social-emotional aspects of learning, such as persistence or frustration. The emphasis is less so on norm-based comparisons, and more so on *ipsative* growth or progress over time by comparing to a person's past performance (Armstrong, 2006). The use of informal assessments that are responsive to individual students' needs allows teachers to offer immediate feedback and to make appropriate adjustments in instructional materials and teaching practices. For example, if a young reader is showing signs of frustration with decoding words with short and long vowels, the teacher can adapt by providing a chart with key words and pictures that can be used as a reference until the student internalizes the spelling patterns.

Complementary roles of standardized and individualized assessments

In the aforementioned examples, standardized achievement tests and individualized, informal assessments serve unique purposes in educating the whole child and evaluating the curriculum. However, of greater importance is the manner in which they serve a complementary role. For example, within the area of literacy development, standardized measures that have been shown to be both valid and reliable are needed to document the efficacy of a school's literacy approach or to screen students in order to identify those who may be at-risk for reading difficulties. Relative to standardized achievement tests, informal assessments typically produce information on students with greater variability, and thus with lower reliability, because the goal is to assess *ipsative* growth more so than to assess mastery according to standardized benchmarks. To illustrate with an analogy, if one is trying to maintain a healthy weight, it may be helpful to collect weekly measurements using a weighing scale (similar to informal assessments). These measurements provide instant feedback regarding daily progress that could be used as information to make immediate adjustments and facilitates individualized, short-term goal setting. However, to maintain a healthy weight, it is also important to know how one's weight compares to healthy individuals of similar gender, age, and height using criteria such as Body Mass Index (BMI), in order to assess personal progress relative to similar others. Without comparing oneself to a standardized criterion, it is difficult to know when one is within a healthy range in regards to weight for her or his age and height.

Additionally, the very nature of the format of standardized tests allows measurement of a certain type of learning. For example, on standardized reading tests (e.g., National Assessment of Educational Progress [NAEP] from the US Department of Education) reading comprehension is measured through the use of reading passages with comprehension questions, which measures a students' independent reading ability in an unsupported environment. To illustrate with an example, if a student, Malcolm, performs well on the NAEP reading comprehension, teachers and parents can be fairly confident that Malcolm has sufficient reading skills for this level of text. However, the limits to standardized reading tests are numerous. For example, if a student, Walter, perform poorly on reading comprehension passages from the NAEP, the test results cannot provide teachers with a diagnostic reason as to why. Possibly, Walter could not decode the words, Or could he read the individual words but his fluency was so slow that comprehension was impaired? Or maybe he could decode the words but was unfamiliar with the topic and the key vocabulary words. In short, poor performance on a standardized reading test can rarely inform a teachers' instruction. When useful diagnostic information is not readily available from the results, teachers and schools may resort to generic test-preparation practices to improve test scores. Additionally, a standardized reading test provides no measure of Walter's effort and persistence or motivation on the task - perhaps he gave up halfway through the test. Recent evidence suggests that personality traits are critical for reading success (Niemi & Poskiparta, 2002). Some leaders in the field of reading education even advocate screening for such social-emotional skills in reading (e.g., Johnston, 2005).

Therefore, for even the most achievement-oriented teacher, individualized, informal assessments of reading such as "Running Records" and student observations are compulsory for responsive teaching. For example, by using the informal approach of "running records" a teacher listens to a student read while observing the rate and prosody of reading as well as any miscues. The teacher also observes for signs of frustration and stress, which serve as indicators of whether the student is matched with the appropriate level of learning materials. Ideally, school curriculum would provide enough freedom to teachers so they could select from a “toolbox” that includes a variety of assessments that would serve the diverse (achievement and social-emotional) needs of students in their classrooms. Unfortunately, there are few available assessments, formal or informal, to specifically assess social and emotional aspects of literacy learning (McTigue, Beckman, & Kadaravek, 2007). This lack of readily available measures for teachers to assess students’ social and emotional development remains an area requiring additional research. In summary, a balanced curriculum must include both standardized and informal measurements which focus on academic and social-emotional growth.

Standardized benchmarks versus individualized goals

As the goals and objectives that underlie both standardized achievement testing and individualized, informal assessments are understood better, it becomes apparent that each serves a function in the education of the whole child: Standardized testing ensures that students are meeting yearly benchmarks determined to be prerequisites for skill mastery, individualized. Informal assessments ensure that students are making daily progress toward the yearly benchmarks. Consistent with Vygotsky’s (1978) concept of zone of proximal development and scaffolding, teachers can help student toward daily progress by providing responsive and appropriate feedback and assistance when individualized assessments signal learning difficulties. Thus, we believe that the success of students on high-stakes standardized testing partly depends on their daily progress necessary to build toward meeting standardized benchmarks. Thus, achievement and human development objectives and goals must work synchronously to maximize learning.

Example of benchmarks in literacy development. In literacy development, fluency (i.e., reading with speed and prosody) is a critical skill (Samuels, 2004) because it provides a necessary condition for skilled comprehension. States operationalized research findings to determine fluency goals for students at varying grade levels. For example, state standards in Texas dictate that first graders should be able to read at rate of approximately 60 words a minute (wpm) by the end of first grade. Such guidelines allow teachers to pace instruction so students are making daily progress that will allow them to meet this benchmark by the time they graduate from first grade. State-wide benchmarks help insure that regardless of school district, each student will aim for a similar level of competency.

However, the benchmark of 60 wpm may be an inappropriate goal to use with all students because children advance best when challenged just beyond their current level of mastery. If a student is reading at 20 wpm and nowhere near the benchmark, focusing only on the success or failure in meeting standardized benchmarks would likely lead to the student feeling discouraged and frustrated and developing a negative self-concept. If a student is already reading at 60 wpm, focusing only on the success or failure in meeting benchmarks may foster a sense of complacency, and the student may stop putting forth effort and persistence to develop his or her learning potential. Therefore, to produce the highest level of academic achievement, school curriculum must acknowledge the benefits as well as limitations of high-stakes standardized testing and benchmarks.

Creating developmental goals in alignment with benchmarks. To help motivate students to learn and progress toward meeting benchmarks, goals should be set with specificity, proximity, and difficulty in mind if students are to experience raised self-efficacy (Schunk, 2003). A *specific* goal is individualized and targeted on learning a certain skill or completing a particular task. Similar to effective feedback, the achievement of specific goals is more likely to raise self-efficacy because they are much easier to evaluate than a general goal (i.e., "Do your best") (Schunk). In literacy development, achieving fluency is a specific goal because it sets a measurable criterion to achieve. In order to reach the criterion, daily and short-term goals (including goals that could be met within 15- to 30-minute sessions) result in greater motivation and higher self-efficacy (Schunk). Rather than being proximal goals, benchmark standards such as the 60 wpm goal for reading is a long-term goal for students entering first grade because it is to be achieved by or before they reach the end of their school year. Therefore intermediary goals must be set in the journey towards that goal. This leads to the final criteria of difficulty. Following "Goldilock's Wisdom of *Difficult*" and consistent with Vygotsky's (1978) concept of zone of proximal development, it is important to think about setting goals that are neither too easy nor too hard for a student to attain.

Therefore, returning to the fluency benchmark, an example of a developmentally appropriate goal is that students will be able to read a familiar book at their instructional reading level, at a rate that is 10% more than their current speeds. For example, if Sarah is reading at 30 wpm, she will increase her rate to 33 wpm. In turn, Jane will be challenged to increase her rate from 50 to 55 wpm. Therefore both learners will be aiming for a different rate, but the incremental change will be similar in difficulty. By meeting developmental and benchmark objectives that consider the learner in context, all students will be on their own trajectory to meeting the minimum goal of 60 wpm by the end of the year. In summary, an effective curriculum will maintain high standards of achievement in the role of benchmarks, but also allow teachers to adapt to the needs of individual learners for the purpose of goal setting.

CONCLUSION

In summary, we believe that the needs of the whole child (including academic and social-emotional learning) must be considered and aligned throughout the process of curriculum development. Although traditional school curriculum typically focuses primarily on academic proficiency, we feel that inclusion of SEL competencies with the formal base curriculum will nurture students to develop into educated and psychologically- and emotionally- healthy members of society. Additionally, we believe the developmental and academic achievement needs and objectives of learners must be integrated into school curriculum, so that one is not simply considered as an "add on" to the other. Such integration may be the most efficient and effective approach to promote academic success and social-emotional health. Time spent on SEL development should not be considered as "lost instructional time" because effective SEL development will promote academic learning as evidenced in increased achievement and standardized test scores. Furthermore, assessments need to reflect such principles by embracing both standardized and individualized tests of learning and progress. As of 2007, the Association for Supervision and Curriculum Development (ASCD) launched its Whole Child Initiative to ensure that all children are healthy, safe, engaged in learning, supported by caring adults, and academically challenged. Curriculum development plays a vital role in carrying out such initiatives by inclusion of efficacious, evidence-based teaching practices and instructional materials in classrooms while ensuring that each school district could decide from these resources those that best match their needs and circumstances.

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Chapter 20

INTEGRATING MEDIA EDUCATION INTO LIBERAL STUDIES: A POSITIVE RESPONSE TO CURRICULUM REFORM IN HONG KONG

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ABSTRACT

Media education has been around for quite some time in the West (Bazalgette *et al*., 1990), but only started to gain acceptance in Asia (Cheung 2005), particularly in Hong Kong, in the last decade. Recently, it has been gaining more attention in Hong Kong thanks to the curriculum reform in which Liberal Studies will become one of the four core subjects to be taken by students in the New Senior Secondary Curriculum and media is one of the six themes to be studied in the subject of Liberal Studies. This paper argues for the need for teaching media education in liberal studies and shows the many connections between the two subjects that facilitate this integration.

Key words: Media education, liberal studies, integration, Hong Kong, liberal education, curriculum reform

INTRODUCTION

Media education has been around for quite some time in the West (Bazalgette et al., 1990), but only started to gain acceptance in Asia (Cheung, 2005), particularly in Hong Kong, in the last decade. During this time it has progressed from being an area about which little was known to being a subject which an increasing number of schools are adopting as part of

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their curriculum or extra-curricular activities. In Hong Kong, however, media education has not been the only ‘subject’ with demands for curricular space. Over the last ten years, the importance of sex education, environmental education, and civic education have all been emphasized, but they have still not been able to gain much ground in the school timetable, and are considered as marginalized curricula. What happened then to spur the development of media education in Hong Kong? Cheung’s (2008) study identifies education reform as an important source of development of media education. The recent education reform in Hong Kong has given media education a more significant place, as an elective in a core subject, Liberal Studies. The argument I wish to make is, in essence, a simple one: media education can and should be integrated into liberal studies for the benefit of both these subjects. The combination not only provides fresh materials for honing media literacy skills, but also contributes to reaching the important goals of liberal studies. In what follows, I first attempt to describe curriculum reform in Hong Kong, and then give a theoretical definition for liberal studies. I next argue for the need for teaching media literacy skills (consumer skills) in liberal studies and show the pedagogical similarities between the two subjects that facilitate this integration. I then consider why and how media literacy skills (user and producer skills) may facilitate and contribute to the discussions and inquiries going on in liberal studies classes. I then show how media education can be better integrated into liberal studies through a “contextual” approach. Having stressed the connections between media literacy and democracy as well as globalization, I conclude with an analogy that shows the inherent link between liberal studies and media education.

EDUCATION REFORM AND MEDIA EDUCATION IN HONG KONG

The development of media education has been rapid in Hong Kong. Although Hong Kong is a media rich city, media education was a term unheard of until the nineties, when the University of Hong Kong offered it as an elective course to participants of its Postgraduate in Certificate of Education program in 1996. Since 2003, *Media Education in the New Hong Kong Curriculum* has been offered as an elective to students taking the Master of Education programme at the University of Hong Kong. Since then, the growth of media education in Hong Kong has become increasingly more visible and among the many factors accounting for its growth, the most significant has been the reform in education.

Society now is very different from what it used to be, and in order to keep pace with the changing world and to nurture students so as to meet the needs of tomorrow’s society, education reform is inevitable. The new wave of education reform has set new agendas in education: apart from the traditional emphases on ethics, intellect, physical fitness, social skills and aesthetics, schools in Hong Kong are now expected to produce a new generation of students who can learn on their own, think for themselves, and explore new arenas of learning. These reforms have influenced, directly or indirectly, the development of media education in Hong Kong.

In the document *Education blueprint for the 21st century: review of the academic system* published in 1999, words like ‘student-centered’, ‘self-learning’, and ‘motivation’ were mentioned frequently (Education Commission, 1999). Moreover, the document questioned whether the media were ‘aware of their powerful influence on the formation of values and learning of language by young people', and asked whether the media should 'disseminate information to the public, and help young people develop positive values, distinguish right from wrong and broaden their horizons' (Education Commission, 1999:28). That set the scene for media education, which aims to help students develop logical and creative thinking, through the critical analysis of the media messages that they are exposed to every day. The nature of media education is student-centered and students are more motivated to learn through discussing the contents they enjoy. Furthermore, they can engage in producing media products in the form of campus newspaper, radio, and TV creatively at a later stage.

Another suggestion in the document was the introduction of key learning areas to replace the fixed subject boundaries. One of these key learning areas was Personal, Social and Humanities Education (PSHE). Media education, a relatively new concept, which had not previously been covered in the Education Department's official guidelines, was here described as an element in cross-curricular programs, and a possible component of this key learning area in the consultative document. This was an indication of a growing awareness of the importance of media education on the part of policy makers. Media education was finally on the official agenda.

THE NEW SENIOR SECONDARY CURRICULUM

The Education Bureau in Hong Kong conducted a review of the academic structure of senior secondary education to be adopted in 2009, and has proposed a restructuring in subjects available to students. Among them, Liberal Studies, Chinese language, English, and Mathematics are core subjects to be taken by students. Liberal Studies is a subject which developed in the early nineties, and although not many schools have adopted it in their curricula, it will become a core subject with the following aims:

> Liberal Studies aims to broaden students' knowledge base and enhance their social awareness through the study of a wide range of issues. The modules selected for the curriculum focus on the themes of significance to students, society and the world; and they can help students to connect different fields of knowledge and broaden their horizons. The learning experience provided fosters students' capacity for life-long learning so that they can face the challenges of the future with confidence (CDC, 2007:1).

The component of media education is recognized in the Liberal Studies syllabus as stated in the document (CDC, 2007:4):

> As the coverage of Liberal Studies includes contemporary issues, media resources are important sources of information apart from teachers' handouts and other learning and teaching materials. Students will learn to critically evaluate information, phenomena, and ideas presented in the media, so that they can distinguish between fact and opinion and sense objectivity versus and bias. Through discussion of issues in these resources, students will learn to base their conclusions on sound evidence and other relevant sources of information, rather than on ignorance and prejudice.

Moreover, students are required to conduct an Independent Enquiry Study with media being one of the six suggested themes.

DEFINING LIBERAL STUDIES

Although sounding similar to liberal arts and often confused with them, Liberal Studies differs significantly from the traditional liberal arts curriculum and general education Whereas liberal arts consist of disciplines of knowledge to be studied as independent subjects, liberal studies is an independent subject.. In the New Senior Secondary Curriculum in Hong Kong, Liberal Studies comprises merely three non-specialized areas of study: Self and Personal Development; Society and Culture; and Science, Technology and the Environment. At the surface level, therefore, it would appear that liberal studies represents exactly what liberal arts are distinguished from. Indeed, one of the chief reasons for introducing liberal studies is to counter the negative effects of focusing solely on traditional, specialized courses, as stated in the following statements.

> Liberal Studies provides opportunities for students to make explicit connections among different disciplines, examine issues from multi-perspectives, and construct personal knowledge. The subject is indispensable for the nurture of a young mind (CDC, 2005:5).

> Liberal Studies, by its name, and especially its Chinese equivalent, may sound similar to General Education or Liberal Education in universities, but it is different in nature, and is not necessarily tied to any particular notion of humanism or classicism (CDC 2005:6).

Liberal Studies also differs from liberal arts in teaching approach. Whereas a liberal arts curriculum aims simply to *expand*, or add to students' knowledge stock, Liberal Studies seeks not only to expand, but, more importantly, to *integrate*, interconnecting different bodies of knowledge and combining them into a coherent whole. For example, whereas liberal arts classes often require a number of teachers coming from diverse backgrounds and specializing in their respective subjects, Liberal Studies classes are usually taught by one, all-around teacher able to deal with a variety of issues and subjects and, more importantly, to guide students in their search for connections between subjects.

Furthermore, Liberal Studies has a distinctive moral dimension not apparent in liberal arts curriculums. As stated in the Second Draft, one of the important aims of Liberal Studies is 'to help students develop positive values and attitudes toward life, so that they can become informed and responsible citizens of the country, society, and world' (CDC, 2005:4). Rather than only finding facts and developing theories, liberal studies also aims at training students to become moral, critical, and active thinkers – or, in other words, a better citizen. In connecting a diverse range of disciplines – the eight Key Learning Areas in this case, Liberal Studies is not so much concerned with training academic generalists able to handle a variety of tasks and solve different problems as it is with developing in students a concern for the well-being of humanity in everything from politics to biology. Liberal Studies is, ultimately, a form of moral education.

It should be noted, however, that Liberal Studies should not be equated completely with moral education. Whereas the latter simply teaches morality *as* morality, Liberal Studies uses contemporary, real-world issues and events as entry-points for moral discussions from various perspectives. The purpose of this issue-oriented, cross-disciplinary approach is to help students learn morality by actively, critically, and realistically thinking rather than by rote, allowing them to discover in everything a *moral* dimension. Liberal Studies is, therefore, not aimed at making students think morally – in fact, there are as yet no definitive answers to moral issues like abortion and embryonic research –, but rather at allowing them to think of everything in moral terms and engage actively in moral discussions.

THE NEED FOR MEDIA EDUCATION

In marked contrast to traditional, specialized subjects, Liberal Studies is issue-oriented, encouraging students to study and discuss current, far-reaching, usually hotly debated issues and events: How should Hong Kong residents' living standards be improved? What is the impact of the reform and opening-up policy? Is globalization a blessing or a curse to humanity?

These issues and events, in turn, come primarily through the mass media, usually in the form of constructed texts which may or may not be accurate and reliable, but nevertheless exert a profound influence on our perception and attitudes. This all-pervasiveness of contemporary mass media is summed up well by Silver (1992:2), who states: 'Media no longer just influence our culture, they are our culture'. Indeed, virtually the only information on which students might base their discussion and exploration of liberal studies topics is media evidence. In discussing the issue of genetic modification, for example, little knowledge, facts, statistics, opinions and even misconceptions could come in forms other than media messages, whether through biology textbooks, TV news, newspaper debates, or internet rumors; the topic is too remote to allow sources other than the mass media. Therefore, without the ability to critically read, view and analyze media texts and to discern the special techniques and representation patterns being used, students will likely engage in a false debate of prevalent fallacies and groundless arguments. Students need, as Thoman (2003:1) put it, 'to know how to verify information themselves, how to check sources and how to compare and contrast different versions of the same information in order to detect bias or political spin control'. In other words, media literacy skills are needed if students are to be able to conduct critical, informed discussions in a media-saturated environment.

The question should be raised, therefore, as to how educators may best improve students' learning experience by incorporating media education skills into the liberal studies curriculum. Do we need to create a separate branch of study? The answer, it seems to me, is no. Media literacy, after all, is a type of literacy, and given the importance of traditional literacy in all subject areas that require reading and writing abilities, the best use of media literacy would undoubtedly be to let it permeate the entire curriculum. For each topic, several questions could be asked: What did you know or think you know about this? Where? In what form did the message reach you? How was it constructed? What was present, and what was absent? What special techniques were used? Why? How does the way it is represented relate to itself, the issue at hand? Has your idea about the issue become clearer after analyzing its representation by the media? This combination of media education with Liberal Studies, then, allows students to critically analyze media messages, to compare preconceptions with discoveries, to engage in enlightened discussions, and ultimately to enhance both their media literacy and citizenship skills.

PEDAGOGICAL SIMILARITIES

This combination can be further facilitated by the closeness in the approaches to the teaching of media education and liberal studies. The debate over the ideal pedagogy of education has been going on for centuries. In his essay *Teaching and Learning*, Peter Newsam differentiates between two extremes: a traditional approach to education, in which the purpose of teaching is to ensure that those taught acquire a prescribed body of knowledge and set of value, and a progressive approach where the focus is on the student and his or her stage of development. Under this dichotomy, liberal studies and media education both lie somewhere near the progressive end, with their emphasis on student-centered, activity-focused, and experiential learning and open-ended discussion.

Whereas subjects using traditional approaches are difficult to combine (e.g. combining chemistry and history), a progressive approach has proven to be extremely flexible and inclusive. For example, discussions on media representation of the poor can be naturally extended to the section of Quality of Life in the Liberal Studies curriculum where students consider the problem of poverty as well as its remedies. Both the learning and teaching of liberal studies and media education adopt a student-oriented approach. Students will be equipped with teaching approaches such as issue-enquiry and problem-based learning to help students to see the connection between different themes and disciplines, acquire knowledge and understanding of the issues, analyze from multiple perspectives in different contexts, and make reasoned judgments.

LITERACY AS RESEARCH TOOLS

Media education is useful to Liberal Studies not only as a consumer or reader skill. As pointed out by Davis (1992), media education provides important user and producer skills as well. These skills will be of great use as research tools that facilitate students' independent inquiry study. For one thing, in helping students become sophisticated media users, media education enables them to use appropriate technologies such as the internet to locate appropriate resources for independent enquiries. Students interested in environmental issues, for example, may need to acquire sufficient computer literacy for finding the right data and facts (What is the air pollution index?) from the internet. For another, media education also allows students to become adept media producers. For example, for students who wish to study the impact of globalization on the community in which they live, media production skills (how to use digital cameras, how to edit video clips, etc.) will be required if they are to go outside and record their own media evidence.

GOING BEYOND THE TEXT

In their paper *The Struggle over Media Literacy*, Lewis and Jhally (1998) argue for a contextual rather than text-centered approach to media education. The goal of media education, they stress, is to help people become sophisticated citizens rather than sophisticated consumers. A contextual approach, with its emphasis on the structure and economic relations of media institutions rather than mere textual analysis, is just the answer. The word *context*, however, is open to interpretation. Narrowly defined (and from Lewis and Jhally's perspective), it refers to the immediate context of production and reception: Who is behind this message? Who is represented, and who is absent, and why? In a broader sense, however, it could encompass the entire complex array of social, political, and economic factors that shape the media industry. The reason is clear: We would not fully understand the media without delving into the world which they both represent and are influenced by. In other words, to prepare youth for literacy and citizenship, it is necessary not merely to help them 'go beyond the text', as suggested by Lewis, but also 'go beyond the media'.

For example, in Hong Kong, we could consider the issue of Severe Acute Respiratory Syndrome (SARS) coverage in 2003. After students have been asked to analyze media texts, which would yield arguably little valuable insights into the problem, the question inevitably arises: Why were the media in Hong Kong and the mainland China so different in responding to the crisis? A discussion on the economics of media institutions seems irrelevant. Rather, questions about democracy, the public's right to know, different forms of government, social attitudes, cultural difference, and even public health systems need to be raised and answered. Why does the Chinese government have so much power over mass media? What are the differences between mainland China and Hong Kong in terms of government systems? Which is better, democracy or authoritarianism? How should the government be reformed in order to better serve its people? Going beyond the text gives students an opportunity to look at the problem from a holistic perspective. Only when these issues are solved, it seems, can students become strictly informed media audiences. All these issues fall under the category of Liberal Studies.

This is, of course, not to suggest that only media education benefits from the relationship. Quite the contrary, it could be argued that without introducing important media literacy skills, liberal studies might end up being another general education curriculum whose sole purpose is to 'enrich' students' educational experience. In what follows, I will try to sketch the many inputs made by media education into both the process and the ends of liberal studies.

SUBJECT CONTENTS DEFINED: MEDIA EDUCATION AND LIBERAL STUDIES

A careful examination of the teaching contents of both subjects will reveal that there are a number of important issues that both liberal studies and media education will deal with. The following are two examples.

Democracy and Citizenship

One of the important goals of Liberal Studies in the newly proposed secondary curriculum is not to turn students into specialists in any well-defined academic fields, but to enable them to become informed, rational, and responsible citizens of the country, society, and the world (CDC 2007:5). Through the study of the rule of law and socio-political participation in Hong Kong and the topic on China's reform and opening-up, students would be given opportunities to understand the prevailing political systems and their impact on citizens.

The relationship between media education and democracy and citizenship training is clear. Katz (1993:37) states: ‘Democracy is meaningless without multiple voices.....it is simply impossible to talk about citizenship training in modern society without reference to mass communication’. Aufderheide & Firestone (1993:1) argue that the purposes for media education are ‘citizenship, aesthetic appreciation and expression, social advocacy, self-esteem, and consumer competence’. Ahonen & Virta (1999:248) argues: ‘Citizens’ action and critical thinking in the information society are linked with communication skills and the capacity to influence others. Media education can therefore be considered a key area in civics’.

According to Buckingham (2000), through media education, young people’s identity could be nurtured. In his study of the making of citizens, Buckingham explored the relationship between television and young citizenship by analyzing how teenagers in Britain and the U.S.A. make sense of the television news. His finding was that young people were excluded from the domain of politics, and their lack of interest in politics was the result came from a feeling of powerlessness. Young people do care about things around them and they do watch television news if it is presented in a manner familiar to them. This view echoed what Jon Katz, a media critic, wrote in *Rolling Stone* magazine, that young people prefer the ‘informal’ and ‘ironic’ style of reporting of some cable TV channels to the ‘monotonously reassuring voice’ of mainstream news journalism (1993). Buckingham concluded with a call for media education as a crucial dimension of political education and contemporary citizenship. He wanted to see students discussing political and social issues by actively engaging them; using media they were familiar with. His view echoed the participatory model of citizenship education proposed by Ichilov (1998), which stressed the importance of public participation in discussing and framing public and social issues. Media education helps in this respect, as the media give young people a platform to actively understand and analyze political and social issues, which can be boring if presented in the traditional manner. Through media education, young people can critically reflect on their role, and establish their identity through learning and discussing issues in society as informed and participating citizens.

In what way can media education strengthen democracy? A quick answer would be that it is simply impossible to weed out media influences from politics, or anything political for that matter, and that media education can help individuals know better about those influences and how they might make better decisions or take actions to counter those influences. David Shaw (2003:E20), media critic for the Los Angeles Times, warned against the potential dangers to a democratic society without media literate citizens: ‘unless we teach our children how to read and interpret, understand and analyze the day’s events, we risk raising a generation of civically politically ignoramuses and uncritical consumers, vulnerable not only to crackpot ideas, reasoning and putative despots but fraudulent sales pitches and misleading advertising’.

There are, however, other advantages as well. Media education and Liberal Studies, and all progressive education for that matter, are more democratic. In contrast to traditional subjects, where a top-down, teacher-centered approach is the norm, the teaching and learning of media education and liberal studies are usually open-ended, inviting students to think, reflect, and express rather than memorize and recall. Students and teachers often engage in questions and debates with no absolute answer, and an individualized curriculum has also been practiced by many educators. The result is a more democratic classroom that encourages active participation and freedom of expression. As Davis (1992:12) puts it, 'Democracy in the classroom encourages democracy in public life'.

Media Education and Globalization

While students may debate in their liberal studies classroom whether globalization is a curse or a blessing, any study of this worldwide phenomenon is bound to involve the role of the mass media. Originally economic, globalization, or the increasing world-wide integration of markets for goods, services and capital, has had a profound impact on mass media institutions, leading to global media ownerships being concentrated in a few multinationals and international conglomerates. The forces of political conservatism, typical of powerful multinationals, have led to a trend in journalism toward increasingly 'soft' media content, which has, in turn, deeply altered the course of our society and culture and ultimately individuals themselves. As pointed out by Shah (1997:1), 'consumers of this kind of artificially narrow and perhaps irrelevant information may begin to feel increasingly alienated and disconnected from the civic life of their communities. They may develop a sense that they are without relevant, actionable information and, therefore, powerless to control the course of their own lives'. In other words, globalization has posed a serious threat to the critical thinking abilities and citizenship skills of individual media consumers.

Media education, therefore, provides a powerful tool for students to develop a critical stance towards the cultural impact of globalization, keeping them from being overwhelmed and desensitized in the sea of cultural messages that globalization brings. Numerous questions can be raised which promote both their critical thinking skills and their understanding of globalization itself. What messages, for example, are being sent by multinational media corporations in cultural products such as *the Titanic*??? What are the underlining values, attitudes, and assumptions being spread all over the world by these media giants? What is the consequence of globalization in terms of the 'softening' of news? Are these global media bringing about a homogenized global culture, or a diverse one? By guiding students in understanding globalization from a media literate perspective, educators can help them see not the economic, but the social and cultural dimensions of globalization, which are much more important to the goals of Liberal Studies.

CONCLUSION

The relationship between media education and liberal studies is analogous to that between *literacy* and *literature*. Without sufficient literacy, literatures may not be understood or, more importantly, may not be understood *well*. It is certainly bad to be illiterate, yet it may well be equally if not even more distressing to be literate without being critical: an illiterate person only believes what he sees (and is thus critical toward anything else), whereas an uncritically literate person, indulging in the world of literary fantasy, is much more liable to textual manipulation. To prevent students from seeing inaccurately and acting passively – in other words, to help them become more sophisticated citizens – Liberal Studies needs to equip them with critical eyes and ears. In today's media-saturated world, the means through which this can be done is, undoubtedly, media education.

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