Student Engagement in Technology Rich Classrooms and Its Relationship to Professors' Conceptions of Effective Teaching

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Abstract

The benefit of computer related tools in supporting student learning is influenced by the engaging nature of the learning environment and the design of the learning activities. Professors have considerable role in the design of learning environments and activities and the way they design the environment is found to depend on their conceptions of teaching. However, professors' conceptions of (effective) teaching have not been studied in relation to technology use and student engagement. This dissertation study examined a) professors' conceptions of effective teaching and their perceived technology use in technology rich classrooms, and b) the nature and extent of student engagement in these classrooms and its relationship to professors' conceptions of effective teaching.

Semi-structured interviews were used to obtain data from 13 professors who were teaching in active learning classrooms in a large research university in Eastern Canada in winter 2011. Interview questions focused on capturing professors' conceptions of effective teaching in relation to the course they were teaching in the classroom, their expected learning outcomes for students, their instructional strategies, and the role they saw for computers and the type of software they used and/or expected their students to use in relation to the course. Following interviews with the professors, a survey was administered to their students in the end of the term. The instrument, Student Engagement in Technology Rich Classrooms (SETRC) was developed to determine aspects and extent of student engagement in the context. Two hundred thirty two students consented to participate in the research and completed the paper copy of the survey.

Analysis of interview data using a holistic inductive approach with constant comparison resulted in three conceptions of effective teaching—transmitting knowledge, engaging students, and developing learning independence. Transmitting knowledge highlighted organizing and presenting subject matter to students. Engaging students focused on student involvement in various activities such as discussion, presentation, collaboration, and hands on exercises. Developing learning independence and self-reliance related to holistic development of students as professionals and independent learners. This third conception also considered effective teaching to be designing learning environments with more emphasis on students' involvement.

Principal component analysis with varimax rotation was applied to the student survey data. The analysis resulted in four components of student engagement: cognitive and applied engagement, social engagement, reflective engagement, and goal clarity.

Subsequent multivariate analysis considering professors' conception as independent variable and the four student engagement components as dependent variables yielded significant relationship between professors' conceptions and student engagement. Students in classrooms of professors who consider effective teaching to be developing learning independence/self-reliance reported the highest score on cognitive and applied engagement; the score was the least for students in classrooms of professors who consider effective teaching to be transmitting knowledge. The difference was statistically significant. Concerning social engagement, students in classrooms of professors who consider effective teaching to be engaging students reported the highest score among the three groups and it was significantly higher than scores of students in classrooms of professors who consider effective teaching to be transmitting knowledge.

Analysis results did not show any significant different among the three groups of students in terms of reflective engagement and goal clarity. The study has implication for understanding context-specific conceptions of effective teaching, determining students' course/classroom level engagement, designing and assessing technology rich natural learning environments, and improving faculty development initiatives.

Résumé

Les avantages de technologies d'information et de communication (TICs) comme support d'apprentissage dans le milieu éducatif sont influencés par la qualité engageante de l'environnement d'apprentissage et le design des activités d'apprentissage. Les professeurs jouent un rôle considérable dans le design d'environnements et d'activités d'apprentissage. Il a été démontré que leur conception d'enseignement influe sur le design des environnements d'apprentissage. Cependant, les conceptions d'enseignement (efficace) que possèdent les professeurs n'ont pas été étudiées jusqu'à lors en ce qui a trait à l'utilisation des TICs et l'engagement étudiant. Cette thèse de doctorat a étudié a) les conceptions d'enseignement efficace de professeurs et les perceptions de leur utilisation de technologie dans des salles de classe richement équipés en TICs, et b) la nature et l'étendue de l'engagement étudiant dans ces salles de classe et sa relation aux conceptions d'enseignement efficace des professeurs.

Des entrevues semi-structurés furent employés pour obtenir des données de 13 professeurs qui enseignaient dans des salles de classe d'apprentissage active d'une grande université de recherche dans l'Est canadien durant l'hiver 2011. Les questions d'entrevue étaient centrées sur la capture des conceptions d'enseignement efficace des professeurs en relation aux cours qu'ils enseignaient dans cette salle de classe, leurs attentes vis à vis les résultats d'apprentissage des étudiants, leur stratégies d'enseignement, et le rôle qu'ils percevaient pour l'utilisation des TICs par eux-mêmes et les étudiants dans leurs cours. Suite aux entrevues, un sondage a été mené auprès des étudiants à la fin du trimestre. Le questionnaire, Student Engagement in Technology Rich Classrooms (SETRC) a été développé pour déterminer certains aspects de l'engagement étudiant et son étendue dans

ces contextes. Deux cent trente-deux étudiants ont accepté de participer dans la recherche et ont complété la copie papier du sondage.

L'analyse des données d'entrevue procéda dans une optique holistique par l'entremise d'une approche inductive avec comparaison constante et résulta dans trois conceptions d'enseignement efficace—la transmission des connaissances, l'engagement étudiant, et le développement de l'autonomie apprenante. La transmission des connaissances soulignait l'organisation et la présentation du contenu d'apprentissage aux étudiants. L'engagement étudiant centrait sur la participation des étudiants dans diverses activités telles que la discussion, la présentation, la collaboration, et les exercices pratiques. Le développement de l'autonomie apprenante était relié au développement holistique des étudiants comme des apprenants professionnels et indépendants. Cette troisième conception prenait aussi en compte le design des environnements d'apprentissage avec un plus grand accent sur l'engagement étudiant.

L'analyse des composantes principales avec rotation varimax fut appliquée aux données de sondage des étudiants. L'analyse résulta en quatre composantes: l'engagement cognitif et appliqué, l'engagement social, l'engagement réflexif, et la clarté et la précision des objectifs.

Une analyse multivariée subséquente qui considérait les conceptions des professeurs comme variable indépendante et les quatre composantes de l'engagement étudiant comme variables dépendants a identifié des relations significatives entre les conceptions des professeurs et l'engagement étudiant. Les étudiants des cours de professeurs qui considéraient l'enseignement efficace comme le développement de l'autonomie apprenante avaient les plus hauts scores sur l'engagement cognitive et appliqué; le score le plus bas était réservé pour les étudiants des cours de professeurs qui considéraient l'enseignement efficace comme la transmission des connaissances. La différence était stastiquement significative. Pour ce qui est de l'engagement social, les étudiants des cours de professeurs qui considéraient l'enseignement efficace comme l'engagement des étudiants démontraient le plus haut score des trois groupes et ce score était statistiquement différent des scores d'étudiants des cours de professeurs qui considéraient l'enseignement efficace comme la transmission des connaissances. Les analyses n'ont pas identifié de différence significative entre les trois groupes en terme d'engagement réflexif ou de la clarté et la précision des objectifs. Cette étude est porteuse d'implications pour comprendre les conceptions d'enseignement efficace selon des contextes spécifiques, pour déterminer le niveau d'engagement étudiant pour un cours ou un niveau d'étude, pour le design et l'évaluation d'environnements d'apprentissage riches en TICs, et pour l'amélioration d'initiatives de développement professionnelle.

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Contribution of Authors

The first manuscript is a revised version of my comprehensive exam and is yet to be submitted to a peer reviewed journal. I framed the questions and wrote the comprehensive exam. Dr. Saroyan assisted me in framing the questions and approving the reading list. She also gave me comments on the written version of the examination. When I later decided to convert it to a manuscript she advised me on how to restructure it and gave me feedback on the first version. The relative contribution is about 85% myself and 15% Dr. Saroyan.

The authorship of the second manuscript is shared with Dr. Saroyan and Dr. Mark Aulls. This manuscript is part of the dissertation study where I framed the research question, developed interview protocol, collected and analyzed the data, wrote up the various versions of the manuscript. Dr, Saroyan, as my primary supervisor, has closely supervised the progress of the study in all phases. In fact, she has been the first person I ran to for consultation and she provided feedback on all versions of the manuscript. Dr. Aulls assisted me in conceptualizing the research design and helped me in coding the interview data. He also coded part of the interview transcript for reliability. The relative contribution is 80% myself, 15% Dr. Saroyan, and 5% Dr. Aulls.

The third manuscript is also part of the dissertation study that is accepted for publication by the British Journal of Educational Technology. As in the second manuscript, I assumed primary responsibility in all phases of the manuscript. I framed the research problem, did the review of literature, developed the instrument, collected data and analyzed the data, wrote several versions of the manuscript, and responded to comments from reviewers. Dr. Saroyan assisted me in all phases in terms of conceptualizing the study, developing structure to the manuscript, and providing feedback in all versions of the manuscript. Dr. Bracewell, my co-supervisor, assisted me in the statistical analysis and structuring of the manuscript. He also provided feedback on earlier version of the manuscript when it was submitted for the annual conference of the American Educational Researchers' Association (AERA). The relative contribution is 80% myself, 15% Dr Saroyan, and 5% Dr Bracewell.

Chapter I: Introduction

Student engagement is a desirable educational activity that is related to the quality of student learning and personal development (Nelson Laird & Kuh, 2005; Newmann, Wehlage, & Lamborn, 1992; NSSE, 2008 Report; Pike & Kuh, 2005). Engagement represents active involvement and commitment to academic activities (Astin, 1984; Kuh, 2003; Newmann et al., 1992) and is considered to be a means for active student learning or an end by itself. Its advantage is based on the premise that the more students direct their efforts to educationally meaningful activities and work, practice, and get feedback on a subject, the more they learn about the subject and internalize required skills (Carini, Kuh, & Klein, 2006; Kuh, 2003). Shulman (2002) asserts that although learning begins with engagement and engagement "leads to knowledge and understanding", in higher education contexts, engagement "is not just a proxy for learning but a fundamental purpose of education" by itself because it provides students with opportunities to communicate with new people, to explore new ideas, and to make sense of human experience (p. 40).

Student engagement can be understood differently in different contexts. For instance, it could be understood in terms of interest and intrinsic motivation (e.g., Schroeder et al., 2011), the appreciation of the value of schooling and a sense of belongingness to the school system (e.g., Willms, Friesen, & Milton, 2009), and the amount and quality of efforts students expend on academic and related work (e.g., Astin, 1984; Kuh, 2001). In higher education contexts, Alexander Astin, one of the earliest contributors to student engagement research, initially used the term "student involvement" and defined it as "the amount of physical and psychological energy that the student devotes to the academic experience" (Astin, 1984, p.518). Astin (1984) further asserted that involved students spend more energy on studying and more time on campus, participate in extracurricular activities, and have more interaction with faculty members. Such understanding of engagement is broader in scope and includes participation in extracurricular activities or social events.

Research on student engagement in higher education has followed Astin's conceptualization and has focused on identifying institutional factors that determine student engagement or disengagement. In addition to the premise that active engagement is important for student learning or as an end by itself, a related premise is that policies and practices of institutions influence student engagement and their college experience in general (Pike & Kuh, 2005). Accordingly, research on student engagement has been largely conducted at the institution level with the main purpose of providing feedback for institutional decision makers (Hu & Kuh, 2002; Kuh, 2001, 2003; NSSE, 2008 Report). For instance, The National Survey of Student Engagement (NSSE), since its inception in 2000 as "college student report", has served as an annual report for participating institutions. It determines college quality in terms of the amount of time and effort students spend on their studies and how institutions deploy their resources to encourage student involvement (http://www.nsse.iub.edu). NSSE uses five benchmarks of effective educational practice at national and institutional levels that depict student engagement. These benchmarks include level of academic challenge, active and collaborative learning, student-faculty interaction, enriching educational experience, and supportive campus environment (NSSE, 2008 Report).

To determine engagement at the program level, Kember and Leung (2005a, 2005b, 2009) used survey data from graduating students with the purpose of obtaining evaluative information and program-level feedback for departments. They examined the relationship between students' development of general capabilities such as critical thinking, lifelong learning, adaptability, and problem solving and their perception of the teaching and learning environment. They collected data from over 2548 graduates of Hong Kong University (all from one year) using an instrument that has two scales—capability, with nine subscales, and teaching and learning environment, with four subscales. They performed structural equation modeling to relate the two sets of subscales. They reported that the active nature of the teaching and learning environment is related to the learning outcome and the intellectual subscales of graduate capabilities. The learning outcome subscale represents knowledge of the discipline and developing career relevant knowledge and skills. The intellectual capability subscale relates to critical thinking, creative thinking, ability to pursue life-long learning, problem solving and adaptability (Kember & Leung, 2005a, p. 163). This finding provides justification for the considerable emphasis higher education institutions place on providing active learning environments for their students (NSSE, 2008 Report; Pundak & Rozner, 2008; Shulman, 2002).

Given the results of engagement research at institution and program levels, a logical extension is to examine and understand the concept of engagement at the classroom and course level. This extension is particularly important because findings of institution and program level research are less informative for professors and instructional designers who are at the front line of creating learning environments and will need greater insight as to what student engagement looks like at classroom or course level; more so in technology rich environments. If there is a relationship between learning environment and student engagement as well as learning environment and student capabilities (Hu & Kuh, 2002; Kember & Leung, 2005a, 2005b; Pike & Kuh, 2005), such relationship needs to be examined at the course and classroom level where the effort of students is demonstrated more clearly. More importantly, this needs to be studied in relationship to how professors view their teaching because faculty conceptions of teaching are reported to influence their instructional strategies. By extension, their strategy could influence student engagement as well as their choice and use of tools including computers in their teaching.

Universities establish active learning environments involving different types of computer-related technologies to provide engaging and interactive learning experience and a "climate that fosters conceptual change" (Dori & Belcher, 2005, p. 248; McGill University Teaching and Learning Services, 2009; Pundak & Rozner, 2008). Theoretically, active learning environments are based on constructivist orientation to teaching and learning and are student-centered (Grabinger, 1996). It is logical to hypothesize that students' engagement and judicious use of resources such as computers and related tools is facilitated when there is alignment between teaching approaches and the physical environment.

Empirically, however, no study has examined the relationship between professors' conceptions of teaching as it relates to computer use and student engagement. From research on university teaching, we know that professors' conceptions of teaching are related to their teaching approaches and strategies and their conceptions may be influenced by the teaching and learning context (Norton, Richardson, Hartley, Newstead, & Mayes, 2005; Trigwell & Prosser, 1996b). There is, however, paucity of research on how professors view effective teaching in technology rich contexts and how their conception relates to their use of computers in teaching and to student engagement in that specific context. Considering the context specific nature of conceptions (Entwistle, Skinner, Entwistle, & Orr, 2000; Entwistle & Walker, 2000) and the importance of student engagement for their learning and development, understanding the relationship between the two constructs will have significance for enhancing active learning through faculty development activities, for designing learning environments, and for assessing student engagement at course and classroom level.

The purpose of this dissertation is, therefore, to understand professors' conceptions of effective teaching, their perceived use of computers in their teaching, and student engagement—all in the specific context of technology rich classrooms. The dissertation is organized into three manuscripts. The first manuscript critically reviews two sets of literature –the literature on the use of computers as learning tools, more specifically, cognitive tools and the literature on effective university teaching, with the purpose of framing a type of teaching that uses computers as learning tools. The manuscript concludes with the reconceptualization of effective teaching as design of learning environments and delineates features of such environments. The second manuscript determines professors' conceptions of effective teaching in relation to a course taught in active learning classrooms and subsequently, relates these conceptions to their perceived use of computers in their teaching. The third manuscript is a study that explores the nature and extent of student engagement in technology rich classrooms and the relationship of this engagement to professors' conceptions of teaching.

Chapter II: Manuscript I

Design of learning environments: A bridge between use of computers as learning tools and effective university teaching

Engida Gebre and Alenoush Saroyan

Abstract

Research on the use of computers for student learning in university contexts mainly focuses on the learning aspect and rarely makes reference to effective university teaching or the role of the professor in fostering learning. Conversely, research on effective university teaching seldom mentions computer use as means to foster effectiveness or as an attribute of teaching expertise. In this paper, an argument is made for reconceptualization of effective teaching in terms of designing learning environments to foster students' active engagement. Such conceptualization enables the use of computers as learning tools. We first provide a critical review of the conceptual and empirical literature on computers as cognitive tools and identify features of computer-based cognitive tools in classroom environments. We then synthesize features of effective university teaching as it relates to student learning. Finally, we propose characteristics of natural or classroom learning environments that bridge effective teaching and use of computers as learning tools. We also discuss implications for research and teaching practice.

Introduction

The use of computers and related technologies and their impact on university teaching and learning have often been criticised for reinforcing the same traditional approaches to teaching rather than adding value to the teaching and learning process. One of the reasons often cited in the literature is the tendency of researchers, professors, and administrators to focus on the technology itself without considering the educational rationale and the teaching and learning context under which the technologies are appropriated (Kim & Reeves, 2007; Mishra & Koehler, 2006; Selwyn, 2007). In the same vein, studies on effective university teaching rarely refer to the use of tools, especially computers and related technologies, as an integral part of or means to effective teaching. Despite their dynamic and reciprocal relationship, teaching and student learning are often studied separately (Shuell, 1993) and more so in the context of using technology for both teaching and learning purposes.

The purpose of this paper is to advance a discussion that bridges the two research areas—use of computers as learning tools and effective university teaching—by framing effective teaching as designing learning environments for students to actively engage in self-regulated, constructive processes. First we review the literature on the use of computers as learning tools, more specifically as cognitive tools as elaborated in both the conceptual and empirical literature, and the role these tools play in supporting student learning. Further, we identify characteristics of cognitive tools used in natural teaching and learning contexts such as classrooms. Second, we present a discussion of effective university teaching, drawing from two bodies of work—exemplary university teaching and conceptions of (effective) teaching. The arguments we present lead us to a synthetic perspective, namely that effective teaching as facilitating student learning and designing of learning environments, which can be a bridge between enacting effective teaching and using computer technologies for student learning.

Computers as Learning Tools

One area of research on the use of computers for student learning that often reports positive effects is the study of computers as cognitive tools. Pea (1985), one of the early adopters of this term, defines cognitive tools as any medium "that helps transcend the limitations of the mind, such as memory, in activities of thinking, learning, and problem solving" (p. 168). This definition appears to be more generic and one that includes non computer tools such as written languages. Kozma's (1987) definition is more specific to computers. It states that cognitive tools are "software programs that use the control capabilities of the computer to amplify, extend, or enhance human cognition" (p. 21). Jonassen and Reeves (1996) have also defined computer based-cognitive tools as "… technologies, tangible or intangible, that enhance the cognitive powers of human beings during thinking, problem solving, and learning" (p. 693). In addition to cognitive tools (Kozma, 1987; Lajoie & Derry, 1993b), other terms such as "cognitive technologies" (Pea, 1985), "technologies of the mind" and "partners in cognition" (Salomon, Perkins, & Globerson, 1991), and "mindtools" (Jonassen, 2000) have been used for the same concept. What is common in this body of literature is that it predominantly supports the view that computer technologies, when used as cognitive tools, have the potential to significantly contribute to aspects of student learning; and this view is common in both the conceptual and empirical literature.

In the conceptual literature, different researchers have argued that computer-based cognitive tools, when used in learning-centered environments, facilitate constructivist learning activities and support the creation of personal knowledge (Iiyoshi, Hannafin, & Wang, 2005; Jonassen & Reeves, 1996), facilitate multiple ways of knowledge representation (Jonassen, 2003; Jonassen & Carr, 2000), and partner the learner in cognitive activities (Jonassen, 2000; Salomon et al., 1991). Problem solving is an integral part of everyday professional life and the central part of problem solving is adequately representing it (Jonassen, 2003). Cognitive tools can help in this regard by allowing learners to externalize their internal representations. Internal (mental) and external representations of problems are interrelated (Zhang, 1997) and the more the two representations are integrated the better the learners' performance in their learning and problem solving activities (Jonassen, 2003). External representations, especially in the context of problem solving, involve use of tools and physical configurations (Zhang, 1997). Computer tools such as semantic networks, expert systems, and databases can be used to facilitate students' representation of conceptual and procedural knowledge (Jonassen, 2000, 2003).

Salomon et al. (1991) identified two "cognitive effects" of computer-based cognitive tools. The first is "effects with" and the second is "effects of" the tools. Effects *with* refers to what learners gain during the learning process while working with the tools on different activities such as problem solving, information analysis, and hypothesis testing. Computers provide cognitive partnership to users when they are considered as tools we "work with" rather than as "machines that work for us" (Salomon et al., 1991, p.3). That is, these tools provide the affordance that learners can take advantage of in solving problems and representing their understanding of issues. They also minimize intellectual burden by taking on the routine part of the task at hand and leaving the learner with the opportunity to engage mindfully both in the use of the tools and in the process of thinking and making strategic decisions related to the task (Lajoie, 1993). The partnership between the learner and computer based cognitive tools necessitates carefully determining the balance between what tools do to people, i.e., affordances (Pea, 1993) and what people do with the tools, i.e., agency of the user. For example, computers should not be considered as machines that students learn *from* where they replace the teacher/expert (Derry & Lajoie, 1993) or learn *about* where topics about the hardware and software tools are treated as central issues in the learning process (Jonassen, 2000). They have to be resources available to learners to actively work *with* and use in dealing with their academic activities.

Effects *of* computers relate to what remains with the learners after their experience with the technologies. The interaction of learners with tools can lead to cultivation of skills and internalization of procedures which lead to "cognitive residue" (Salomon et al., 1991) such that developed skills that can be used at a later time in dealing with similar problems and situations with or without the same tools.

The empirical literature has also documented various learning situations where computers have been used as cognitive tools with positive effects on student learning and achievement. Such use of computers in postsecondary contexts and courses has been reported to improve students' satisfaction and learning of literacy (Lo, Affolter, & Reeves, 2002), support medical diagnostic problem solving (Danielson et al., 2007), develop learners' systems modeling and understanding ability (Hung, 2008), and enhance learners' problem representation and problem solving (Liu et al., 2009).

Danielson et al. (2007) reported results of studies where they examined the impact of a cognitive tool called "diagnostic path finder (dP)" on student learning and achievement. Their study also determined perception of students about the usability of the dP. The diagnostic path finder was used to support veterinary medicine students in learning clinical pathology that involves working on numerous cases. Their findings showed that students who used the dP significantly outperformed those who did not use the tool in final exam scores. They also reported favourable student perception for the cognitive tool. Hung (2008) examined graduate students' performance in a systems thinking and modeling course using a pre-post design involving use of modeling software called "powersim" as cognitive tool. The study reported that post test scores were significantly different from pre-test scores especially in the representation of systems models in terms of connectivity, cause-and-effect relationship, and feedback loops.

Similarly, Liu et al. (2009) examined cognitive tool use patterns at different stages of problem solving process among 61 undergraduate students in education. Students used a hypermedia program known as "Alien Rescue"—a tool that is designed to assist students in a problem solving context that involves identifying an appropriate home within a solar system for different alien species. The study reported significant relationship between use of tools and cognitive processes and the use of different tools at different levels of the problem solving process. The positive results of computer-based cognitive tools for student learning extend beyond the post-secondary environment as similar favourable results are reported in the k-12 context (e.g., Bera & Liu, 2006; Manlove, Lazonder, & de Jong, 2009; O'Neill & Weiler, 2006; Stahl, 2006).

There are two aspects that stand out in these studies and in the general literature on the use of computers as cognitive tools that can guide their use in classroom contexts. One is that the focus lies on students using the tools, and the other is that students use the tools for clearly defined, learning related purposes involving high level cognitive engagement. Notwithstanding these positive results, three points are worth mentioning about the literature on computers as cognitive tools.

The first is the focus of the research on learning and the exclusion of teaching from the equation. Studies largely focus on how students learn using the tools and rarely mention the role of the teacher or instructional designer in facilitating the learning. The availability of cognitive tools for students does not necessarily guarantee proper use and there are direct and indirect pieces of evidence supporting the need for directing student learning activities while using technologies (Papert, 1987; Salomon et al., 1991; Schmid et al., 2009). Students may spend much time in front of the computer but may not use it for proper academic tasks. The use of computers as cognitive tools needs to be related to and discussed with the role of the professor and instructional designer.

The second issue is the lack of agreement on what constitutes a cognitive tool (Kim & Reeves, 2007). Is it the features of the tool or the nature of use that makes a computer a cognitive tool? Arguments in the conceptual literature often tend to emphasize the notion that it is the way the tool is deployed and appropriated that makes it a cognitive tool rather than the special features of the tool *per se*. According to this view, the same tool may be a cognitive tool or a productivity tool based on the way it is utilized

(Kirschner & Erkens, 2006). Examples provided in the conceptual literature tend to refer to relatively general purpose, open-ended tools such as databases, spreadsheets, semantic networks, modelling tools, programming languages, and other related applications (Iiyoshi et al., 2005; Jonassen, 2000, 2003; Jonassen & Reeves, 1996). Jonassen (2000) suggested that mindtools "are readily available general computer applications" (p. 18). Tools used in empirical studies, however, are more topic-specific in that they are designed to bring about learning a specific topic in a course or to perform a specific task often in laboratory contexts. Besides, these tools are not readily accessible to professors and their use in natural settings outside of the research context is minimal, if any. Jonassen (2000) reasoned in favour of using readily available general purpose applications because no matter how many of these topic-specific tools are developed in different laboratories, the total does not make a fraction of the topics covered in school curricula. The transition from the laboratory to the natural environment also introduces a host of challenges both for the researcher and the classroom teacher (Cognition and Technology Group at Vanderbilt, 1996).

The third issue of concern relates to the fact that the use of cognitive tools focuses mainly on individual rather than the collaborative and social aspect of learning. When there is a collaborative component (e.g., Lajoie et al., 2006), it is in online rather than a face-to-face environment. The collective result of these issues of concern is that the application of cognitive tools in natural classroom environments is at best "too brief and/or inappropriate" (Kim & Reeves, 2007).

Computer-based Cognitive Tools for Natural Contexts

Studies have described the benefits of cognitive tools to student learning when used in certain ways but they have rarely delineated the common features of cognitive tools nor have they convincingly classified which tools can be considered cognitive tool and which ones are not. Lack of a common understanding about the design and features of computer-based cognitive tools can have implications in the use of these tools in classroom or research settings. One way to address this is to adopt an enhanced perspective of conceptualizing a cognitive tool as the combination of its affordances and learner agency. Kim and Reeves (2007) elaborated on this perspective in their extensive synthesis of the cognitive tool literature stating that “the learner, tool, and the learning activity form a joint learning system, and the expertise in the world should be reflected not only in the tool but also in the learning activity within which learners make use of the tool” (p. 207). Such a view broadens the scope and considers the importance of the holistic learning context and the alignment of purpose, activity, and tool. It shifts the focus from the technology *per se* to the learning environment (Bain, McNaught, Mills, & Lueckenhausen, 1998) and brings to the fore the role professors and instructional designers can play in designing the learning environment. The following three characteristics are highlighted to describe this contextual and holistic view of tool use and enhanced conceptualization of cognitive tools.

The first characteristic is strategy for learners’ cognitive engagement (Sugrue, 2000). Learning is a mental process that involves structuring, analyzing, and representing knowledge in a meaningful way. Deep learning is non-automatic and effortful and it requires higher-level processing. If instructional tools and activities are to facilitate cognitive engagement, they need to promote learners' mindfulness (Salomon & Globerson, 1987) as well as interest and willingness to exert effort and to learn difficult concepts (Sheard, Carbone, & Hurst, 2010), and to facilitate creative thinking and knowledge representation. Using the tool to access information or to increase productivity in the form of word processing is not considered cognitive tool application (Kim & Reeves, 2007; Kirschner & Erkens, 2006).

The second characteristic is open-endedness of the tools. Falbel (1991) has suggested that tools may be value-neutral or value-laden. A tool is value-laden in the sense that its designers have some intentions as to how and why the tool is going to be used. But, it is value neutral until it is used by the user in a given way. Open-endedness implies that the tools do not completely dictate that the learners behave in a certain manner or limit their engagement during the learning process; rather, the learner should be able to make active decisions as to how and when to use the tools, set instructional goals, or make sense of the learning material (Kim & Reeves, 2007; Salomon, 1993b). Tools should be enabling, but not restricting factors for students' context-based learning. Open-endedness also represents the extent to which learners can re-appropriate the tools and how the tools address diverse learning needs and contexts (Iiyoshi et al., 2005). Lim and Barnes (2005) refer to this as "learner-control" to represent "the options in the tools that allow students to make decisions" about the purpose and nature of using the tool (p. 493). Essentially, the open-endedness criterion emanates from the solid argument about the importance of learner agency and the centrality of learning activities.

The third characteristic has to do with the collaborative and situated nature of the learning activities (Sugrue, 2000). Social interaction in learning provides students with opportunities for intellectual challenge by forcing them to make their thinking explicit and public and helps them to develop social expectations supportive of learning (Becker & Ravitz, 1999). These, in turn, lead to deeper processing of learning. The situated nature of learning provides relevance, richness, and applicability to the knowledge and experience learners are exposed to.

Theoretical Support for Cognitive Tools

The lack of a theoretical framework in the design and use of computers for teaching and learning (Alexander, 1999; Mishra & Koehler, 2006) has led to disconnected practices and disparate research findings (Roblyer, 2005). The need for theories is not because they provide algorithmic prescriptions on how to use computers in the process but because they provide the heuristics to address ambiguities and the explanations about why a given tool happens or does not happen to be useful (Hannafin, Hannafin, Land, & Oliver, 1997). The use of computers as cognitive tools has both theoretical as well as empirical support. The most commonly cited theory, though general, is constructivism (Jonassen, 1991, 2000, 2003; Jonassen & Carr, 2000; Jonassen & Rohrer-Murphy, 1999). Two main reasons justify the relevance of constructivism in this context. First, it is a learning-oriented psychological perspective that focuses on the learning process and explains how students gain knowledge. As the purpose is to use computers for learning tools, it serves as a framework to organize activities and resources for students. Second, it is grounded on the assumption that learning is about constructing meaning, engaging actively in thinking and problem solving, taking prior knowledge into account, and considering individual differences (Duffy & Jonassen, 1992) as opposed to passively receiving information. What learners do with cognitive tools such as representing knowledge, dealing with problem solving, testing hypothesis, and experimenting with alternatives (Jonassen, 2000; Jonassen & Reeves, 1996; Lajoie, 1993) can be considered part of the active engagement and knowledge building process that this theoretical perspective suggests.

Distributed cognition and expertise development can also be supportive theoretical frames for the use of computers as cognitive tools (Kim & Reeves, 2007; Pea, 1993). Distributed cognition or distributed intelligence (Pea, 1993), is a "functionally oriented" theoretical framework that considers cognition as socially and culturally distributed and involves cultural, social, situational, and technological elements (Salomon, 1993a). Salomon (1993) describes distribution as the "absence of a clear, single locus" and sharing of authority, responsibility, experience, or tasks (p.111). This theory extends meaning of what is considered "cognitive" and implies a situation where cognition or intelligence, instead of being located inside the individuals' mind, is shared or distributed among the individual, other people, tools and the socio-cultural system at large (Hollan, Hutchins, & Kirsh, 2000). A good starting point for understanding the idea of distributed intelligence is considering "people in action" where activities are enabled by intelligence that, in turn, is shaped, and shared by the configuration of people, context, and tools (Hollan et al., 2000; Pea, 1993). This leads to the importance of shared views and objectives as well as the mediating role of tools and artifacts. A person's actions are influenced by what others in the community do and what available tools afford. For example, tools embody the expertise and intelligence of the people who produced them and by using the tools users take advantage of the knowledge of the designers (Falbel, 1991; Salomon, 1993a). According to distributed cognition, computer-based cognitive tools in a learning context modify the very nature of the learning activity and its learning outcomes.

Similarly, the theory of expertise supports the use of computers as cognitive tools. Considering expertise as the characteristic of having superior skills and knowledge accompanied by performance (Ericsson, 2006) and its development as a process of deliberate practice that involves use of tools and artifacts, the expertise literature can be a useful framework for supporting the use of computers in teaching and learning. Experts are characterized by their pursuit of complex problems and by their superior organization and use of knowledge. The theory of expertise can inform the use of computers in teaching and learning in two ways. The first is the study of expert reasoning and knowledge representation in the design and development of intelligent systems such as artificial intelligence, expert systems, and intelligent tutoring systems—often called the modelling approach in the use of computers (Lajoie & Derry, 1993a).

The second and more relevant for the purpose of the discussion in this paper is the importance of tool use for expertise development and the consideration of tool use as part of expertise. Tools or external aids supporting the development of domain specific expertise is reported in disciplines such as physics (Anzai, 1991) and medicine (Lebeau, 1998). Expertise is partly understood in relation to the tools that experts use. For example, understanding the expertise of radiographer or computer programmer becomes more complete when one considers the related tools these professionals use to carry out their professional responsibilities. Considering learning as expertise development, computer related tools can play a significant role in learners' acquisition of advanced knowledge and their pursuit of advanced problems (Spiro, Feltovich, Jacobson, &

Coulson, 1992). Thus, computers are not only learning tools, but also new content and component of expertise that need to be integrated with any course in any discipline (Cox, 2008; Mishra & Koehler, 2006).

Effective University Teaching: A Review

Effective teaching is widely considered to be one of the major inputs for improving quality of student learning, developing subject matter knowledge and competencies, and enhancing lifelong learning skills (Parpala & Lindblom-Ylanne, 2007; Ramsden & Martin, 1996). Universities encourage departments and faculty members to pay attention to quality of teaching and student engagement (Hativa, Barak, & Simhi, 2001; Reid & Johnston, 1999). Some have asserted that what goes on in classrooms during the teaching and learning process accounts for the largest amount of variance in student learning outcomes (Campbell, Kyriakides, Muijs, & Robinson, 2004).

The meaning of effective teaching, however, lacks unified understanding (Bartram & Bailey, 2009) on the part of researchers, teachers, and policy makers thereby making the task of focusing and synthesizing research on the subject fairly difficult. Researchers have employed different approaches and methods to investigate and describe effective teaching including student course rating and related student surveys, classroom observations, and interviews with professors (e.g., Abrami, d'Apollonia, & Rosenfield, 2007; Hativa et al., 2001; Kane, Sandretto, & Heath, 2004; Reid & Johnston, 1999; Young & Shaw, 1999). Considerable portion of research on effective teaching or teacher performance in higher education has been done based on student surveys and course ratings (Benton & Cashin, 2012). In this paper, the scope of the discussion on effective teaching is limited only to professors' perspectives and does not include the literature on student course ratings. This is because the purpose is to relate professors' conceptions of effective teaching to use of tools and design of learning environments. Most of student course ratings do not address the broader construct of learning environments. The student rating literature is also largely based on teacher-centered rather than student-and/or learning-centered models of teaching (Kember & Leung, 2009).

Overall, studies on effective university teaching especially those in which data are collected from professors can be grouped into two based on the purpose and/or research participants. The first group consists of studies that focus on determining elements, aspects, or general characteristics of effective teaching mainly through the examination of the belief and practices of exemplary professors. Thus, the main participants in this set of studies are "excellent" or "award-winning" professors. Examples of such studies include the work of Dunkin and Precians (1992), Hativa et al. (2001), Reid and Johnston (1999), Bartram and Bailey (2009), and Kane et al. (2004). These studies try to capture professors' beliefs about effective teaching and their related practices. By belief, we mean the relatively stable and "typical or characteristic ways in which a phenomenon is viewed" (Samuelowicz, 1999, p. 6). Findings in these studies relate to what professors do as well as to their skills and attributes. The first major element mentioned in these studies is subject matter knowledge and the ability to organize and present it to students. Dunkin and Precians (1992) refer to this element as the "natural priority" given the context (p. 488) and includes the professor's depth of knowledge about the subject, ability to organize the knowledge and present it with clarity, and ability to put the lesson in the larger context of the course and the program (Hativa et al., 2001; Kane et al., 2004; Parpala & Lindblom-Ylanne, 2007; Reid & Johnston, 1999).

Another element relates to creating positive classroom environment for interaction and collaboration among students and for interaction of students with the professor (Hativa et al., 2001; Parpala & Lindblom-Ylanne, 2007). This theme also refers to the personal attributes of the professor such as approachability and interpersonal relationship skills (Kane, Sandretto, & Heath, 2002; Reid & Johnston, 1999). The third element has to do with motivating students and making them enthusiastic about the subject and their learning. This also includes professors' interest in the subject they are teaching in a way that transmits the same enthusiasm to students (Dunkin & Precians, 1992; Hativa et al., 2001). The final component of the exemplary teaching literature is encouraging students' independence in learning (Dunkin & Precians, 1992) which involves individual activity for students and connects the "important objective of university teaching" (p.488) with instructional strategy.

This body of research also compares attributes and practices of "expert" and novice professors. For example, Dunkin and Precians (1992) reported that award winning lecturers mentioned more elements of university teaching as opposed to most of the novice lecturers who mentioned only one of the elements the researchers identified. This body of research is essential for better understanding of effective university teaching. What is missing, however, is sufficient description of teaching as it relates to processes and activities of student learning. Effective teaching is broader and includes issues of promoting students' personal and affective development among other things (Brophy & Good, 1986). It needs to be understood in terms of students' learning and higher-order thinking (Biggs, 1999). According to Biggs, effective teaching results in a situation where most students use their higher order thinking skills which otherwise only the high-ability students do. As an activity, effective teaching needs to influence students' learning processes and outcomes as well as consider contextual variables (Klauer, 1985; Seidel & Shavelson, 2007).

Another element that needs to be part of teaching effectiveness, which is not often mentioned, is use of resources such as computers to facilitate student learning. The importance of pedagogical expertise together with content knowledge has been the subject of research on teacher knowledge in the k-12 setting since Lee Shulman introduced the concept of pedagogical content knowledge (Shulman, 1987). Pedagogical content knowledge (PCK) is based on the notion that bringing the two areas of knowledge together—content and pedagogy—is fundamental to teachers because it represents unique type of knowledge essential for teaching (Mishra & Koehler, 2006; Shulman, 1987). Mishra and Koehler (2006) rightly extended the concept of PCK to technological pedagogical content knowledge (TPCK) to include knowledge about technology and its application for teaching and learning.

Arguably, two of the major changes since Shulman's introduction of pedagogical content knowledge are the prevalence of computer related technologies in educational environments as well as in the mainstream educational discourse and the dominance of constructivist perspectives in accounts of teaching and learning. Technologies are ubiquitous in classrooms and in day-to-day lives of students. Integrating them into mainstream teaching and learning activities in a way that supports student learning requires harnessing their potential and aligning them with learning material and instructional strategies. Teachers need to have expert knowledge about the reciprocal relationship between content and technology to understand how a technological tool can be used to represent a given subject. In the context of university teaching, an appropriate inquiry would focus on the course level and might ask how the topic or course can be modified to fit to available technology and how the technology can be appropriated to help students learn the course—dealing with the reciprocal relationship between technology and the course in a given context. This knowledge is the basis for good teaching using technologies in constructivist ways (Mishra & Koehler, 2006).

The second set of studies on effective university teaching is related to conceptions of teaching in general with the purpose of capturing the range of categories or variations in the understanding and description of effective teaching (Samuelowicz, 1999). Because of the interest in the range of qualitatively different conceptions, data are not limited to those obtained from award winning or exemplary professors and include experienced professors as well as those with limited experience and, in some cases, doctoral students (e.g., Saroyan, Dagenais, & Zhou, 2009). Conceptions do not represent individual qualities of professors, but rather possible ways of representing the phenomenon of teaching. These conceptions become important in the study of teaching because of their influence on teaching approaches and strategies (Trigwell & Prosser, 1996b) that in turn relate to effective teaching and student engagement. As described below, the understanding is that some conceptions are related to effective teaching especially in terms of promoting constructivist ways of student learning more than others. Conceptions of individuals may be generalizable to other similar situations or may vary from context to context (Marton, 1981). According to Marton (1981) teaching conceptions research is about determining the qualitatively different ways by which professors understand and represent the process of teaching.

With some variations, a large portion of conception studies represent teaching in two-dimensional continuum ranging from teacher-centered, content-oriented to student-centered, learning-oriented (Kember, 1997; Samuelowicz & Bain, 1992; Trigwell, Prosser, & Taylor, 1994). The teacher-centered, content-oriented end of the continuum considers teaching to be transmitting information from the expert professor to the students. What students are expected to learn is defined subject matter content which often comes from teachers, textbooks, and related sources. Similar to studies on exemplary teachers, descriptions of teaching are related to what teachers do (Andrews, Garriso, & Magnusson, 1996). At the other end of the continuum is the student-centered, learning-oriented conception of teaching that focuses on students' conceptual change and development (Kember, 1997; Samuelowicz & Bain, 1992; Trigwell et al., 1994).

According to the teaching conceptions literature effective teaching is expressed in terms of having "sophisticated" conception of teaching and facilitating student learning (Carnell, 2007; Entwistle & Walker, 2000; Kember & Kwan, 2000; Saroyan et al., 2009; Trigwell & Prosser, 1996b). A sophisticated conception is one that represents teaching in relation to student learning with more inclination to developing self-regulated learning and active engagement in the process (Carnell, 2007). Thus, effective teaching is considered to be more than having content expertise and clarity of presentation (Andrews et al., 1996) and includes understanding the subject from learners' perspective, taking into account their background, meeting their awareness and motivating them, and contextualizing the learning experience.

Different researchers have used different terms to describe this student learning oriented dimension of teaching conception, for instance, "promoting lifelong learning"

(Saroyan et al., 2009), "changing student conceptions" (Kember, 1997), "supporting student learning" (Samuelowicz & Bain, 1992), and "student learning focus" (Akerlind, 2004). Fox (1983) used a metaphor of "growing theory" for teaching and described the professor as a gardener. What is common to all is the student- and learning-centered view of teaching. The following four related themes can be drawn as features of this conception of teaching. First, it focuses on holistic development of the student as a person rather than on understanding of specific content. Professors give emphasis to "what is happening to the student as a person" rather than on a narrower goal of "where the student is going in terms of mastering the subject" (Fox, 1983, p. 158). Facilitating students' development and socialization as professionals is part of effective teaching (Akerlind, 2004; Saroyan et al., 2009). The second theme is students' responsibility and independence. Teaching, as it relates to student learning, is viewed as helping students in developing their self confidence and independence in learning. Students are given responsibility for their learning in terms of planning and organizing their work, determining learning objectives, and reflecting on their learning and performance (Samuelowicz & Bain, 1992)—all with the view to facilitate self regulated and lifelong learning for students (Saroyan et al., 2009). The third theme is students' conceptual change and development. Teaching, in this case, deals with helping students to experience conceptual change and development about a phenomenon of their study and the world around them (Trigwell et al., 1994). Effective teaching encourages students' to move away from dual views of phenomenon and to recognize multiple perspectives. Finally, effective teaching emphasizes construction of knowledge as well as critical, original, and creative thinking among the students (Akerlind, 2004). Good teaching has orientation to reality (Samuelowicz & Bain, 1992) and prepares students to deal with authentic problems and helps them to develop broader sense of the discipline.

In summary, research on student ratings aside, the concept of effective teaching in the university context has been studied from two perspectives: the expert teacher perspective and teaching conceptions perspective. The first identifies characteristics and qualities of excellent or exemplary professors and emphasises possession of deep subject matter knowledge among other things. This literature also focuses on what the professor does as a source and provider of knowledge. The second perspective has attempted to capture a range of conceptions of university teaching and presents effective teaching in terms of having sophisticated conceptions and as a process that is related to processes and outcomes of student learning. This view of effective teaching is also based on constructivist perspectives to teaching and learning with more emphasis given to student learning activities where they construct their own knowledge through active and collaborative engagement rather than through passive reception and accumulation of compartmentalized knowledge.

What we can learn from the discussion so far is that research on the use of computers as cognitive tools rarely includes professors and their role in the process. Conversely, research on effective teaching barely mentions the use of computers and related technologies. We argue that this situation can be addressed through a conceptualization of effective teaching as context-oriented design of learning environments that involves appropriation of computers and other context-related tools.

Effective Teaching as Design of Learning Environments

Although the terms teaching and instruction are used interchangeably in the literature, some researchers argue that instruction is broader in meaning and relates to the intentional arrangement of learning conditions and experiences so that students can achieve intended learning outcomes (Anderson & Burns, 1989; Driscoll, 2005; Smith & Ragan, 2005). Teaching, on the other hand, is viewed as interpersonal activity that requires interaction between teacher and students; thus, it is narrower (Anderson & Burns, 1989). According to this hierarchical view of instruction and teaching, instruction "contextualizes teaching" because students' behaviour, teachers' behaviour, and the whole interaction occur within the context of instruction; teaching is an inseparable part of instruction and is related to what the teacher does rather than what the learners do (Anderson & Burns, 1989; Aulls & Ibrahim, 2012).

However, careful analysis of the descriptions of "instruction" and student-centered, learning-oriented conceptions of teaching reveals similarity in purpose, context and processes, and in the expected roles of professors and students. In both cases, there is emphasis on students' learning and what they do in the process. Although students' subject matter understanding is stated as one component of instruction (Aulls & Ibrahim, 2012; Smith & Ragan, 2005), the purpose in general is to bring about desired learning for students and as Smith and Ragan (2005) noted "all instruction consists of experiences leading to learning" (p. 5). As mentioned above, effective teaching as student-centered, learning oriented activity also focuses on qualitative and richer student learning outcomes (Carnell, 2007; Kember & Kwan, 2000).

In both instruction and "sophisticated" conceptions of teaching, context plays a central role for the success of both teaching and learning (Devlin & Samarawickrema, 2010). This importance is partly attributed to the notion that learning and transfer (Perkins & Salomon, 1989; Van Oers, 1998) as well as effective teaching (Devlin & Samarawickrema, 2010) are situated or context dependent. When teaching is viewed as designing learning environments, the context of learning and application as well as the learning processes is considered to be central elements in teaching. Learners have a relatively more active role in terms of planning their learning goals, choosing projects they are working on, reflecting on their learning, and looking out for the support they need. The professor has more of a facilitating role by serving as a guide, supporting the effort of the learner, and providing expert advice and feedback.

Instruction and effective teaching as facilitating student learning underscore the importance of intentional design of learning environments with practical significance for students' learning. Design is a disciplined activity of creating a product that has practical utility (Rowland, 1993) and involves a mix of creative and rational processes with emphasis on practicality and "appropriateness" (Cross, 1982; Rowland, 1993). In the context of designing learning environments or "pedagogical design" (Lakkala, Muukkonen, Paavola, & Hakkarainen, 2008), "appropriateness" can be expressed in terms of bringing about desired learning outcomes, engaging students in the process, considering and balancing context related factors, utilizing resources, and grounding the design within the theoretical and research literature on student learning (Hannafin et al., 1997). Lakkala et al. (2008) identified four components of pedagogical design—technological, social, epistemological, and cognitive. The technological component refers to selecting and integrating appropriate technology in relation to the intended learning process and outcome. The social component relates to advance planning for student collaboration and organization of social space for learning. Cognitive aspect refers to students' awareness about and mastery of the required knowledge and skills. This also includes learners' independence and appropriateness of scaffolding in the process. The epistemological component is the underlying frame for organizing other components and refers to conceptions about knowledge and knowing—product and process of learning.

Grabinger (1996) referred to such learning environments as rich environments for active learning. Rich environments for active learning (REAL) are comprehensive systems of learning and instruction that involve active as well as collaborative engagement of students in authentic and generative learning activities with the goal of integrating or constructing knowledge and achieving higher level thinking and problem solving capabilities (Grabinger, 1996; Kovalchick & Dawson, 2004). These environments are based on constructivist perspectives (Grabinger, 1996) and bring together features of learning-centered teaching and use of computer technologies as cognitive tools in a way that benefit student learning. In essence, REALs are means of implementing constructivist principles in teaching and learning. Accordingly, design of learning environments that involve use of computer technologies and address the issue of "appropriateness" involve the following four features.

Integration of content and context. The main part of what students learn or are supposed to learn at school relates to disciplinary knowledge and skills. Understanding domain specific knowledge is one of the main components of expertise and continues to be part and parcel of learning outcomes. However, situatedness or context specificity is an essential framework of learning and learning theories (Van Oers, 1998). Context specificity or situatedness in teaching and learning relates to particularization of learning experience (Van Oers, 1998) and establishing relationship between what is learned and how it is learned and applied (Brown, Collins, & Duguid, 1989). The need for integration of context in designing learning environments is to situate content understanding to the authentic experience of the learners. In relation to learning and transfer, Perkins and Salomon (1989) referred to the importance of context as the “power of the particular” (p. 18) and argued in its favor from the perspectives of expertise, methods of problem solving, and transfer—all being more fruitful when context is taken into account. Brown et al. (1989) have also suggested that teaching that does not consider the application context ignores the influence of situations on cognition.

Learning and learner-centered approaches/strategies. Another important feature of rich learning environments, which in part is related to context, is espousing learner and learning-centered approaches to teaching. What it means to use student-centered strategies has not always been clear enough (Salomon & Almog, 1998). One way of understanding it is considering prior knowledge, skills, and attitudes of learners in teaching practices (Bransford, Brown, & Cocking, 2000). Prior knowledge is considered to be the organizing factor for the thought processes of students as they make inferences about their experiences (Meyer, 2004). Considering prior knowledge also involves having broader understanding of the concept that includes not only the courses students have taken previously but also their life experiences and inclinations (Meyer, 2004). Another way of understanding a learner-centered approach, which is related to contextualization, is being culturally responsive by incorporating problems and situations of learners into their learning process (Bransford et al., 2000).

A related terminology is learning-centered approach. This refers to a focus on providing successful learning experiences and achieving desired student learning outcomes (Dimmock & Walker, 2004). A learning-centered approach in teaching begins with a well thought learning outcome for the students and involves designing instructional strategies based on both the expected learning outcome and the present status of the learner. In essence, this is about the alignment between the learning outcomes and choice of instructional and assessment strategies (Biggs, 2012; Saroyan et al., 2004). Thus, when learning environments are designed based on concern for students' learning and engagement, consideration of contextual factors, and alignment of outcomes and strategies, they are considered to be rich enough to facilitate active engagement (Barr & Tagg, 1995; Bransford et al., 2000).

Cognitive and social aspects of learning. The third aspect of designing rich learning environments relates to addressing both cognitive and social engagement of students. Learning, especially in the context of advanced knowledge acquisition, is about engaging mindfully, developing cognitive flexibility, dealing with ill-structured problems and transferring problems solving skills to different contexts, and acquiring high level thinking skills (Mayer & Wittrock, 1996; Salomon & Globerson, 1987; Spiro, Coulson, Feltovich, & Anderson, 1988). Addressing and solving ill-structured and context-specific problems requires not only having the required schema or representation of a phenomenon but also the ability to redraw one's representation or schema in a way that helps to address the problem at hand (Spiro et al., 1988). Such student ability can be developed by designing learning environments that offer multiple representations of knowledge, use different authentic cases, and synthesize knowledge from different sources resulting from cognitive engagement.

Cognitive engagement in learning requires intentional or conscious efforts (Mayer & Wittrock, 1996; Salomon & Globerson, 1987). Making conscious effort or "mindful engagement" (Salomon & Globerson, 1987) refers to a "metacognitively guided employment of non-automatic, usually effort-demanding" processes (p. 625). The learning experience should afford students with opportunities to develop reasoning ability and facilitate learners' independent mastery of the learning material and its critical aspects (Lakkala et al., 2008).

The social aspect of learning is considered to be "participatory knowledge construction" process that facilitates individual and collaborative learning (Becker & Ravitz, 1999; Salomon & Perkins, 1998). Using a social approach to the design of learning environments where students work collaboratively provides social scaffolding for the learners (Salomon & Perkins, 1998) because such exposure provides intellectual challenge for students and raises social expectation that support learning (Becker & Ravitz, 1999). Individual and social aspects of learning are interdependent (Palincsar, 1998; Salomon & Perkins, 1998; Slavin, 1991). For example, Hanson and Sinclair (2008) studied the relationship between professors' use of social constructivist approaches to teaching and perceived student achievement as measured by ratings of professors and supervisors of new graduates in work environment. The study reported significant relation between adopting social constructivist approaches to teaching and students' profession-specific skills (work skills and problem solving skills).

Alignment of technological tools and educational rationale. The fourth characteristic of rich learning environments is alignment of tool use with educational rationale. One of the criticisms in the use of computer technologies for teaching and learning in the university context is the lack of alignment between what the educational research informs about how people learn and the way the tools are used in teaching practice (Alexander, 1999; Salomon, 2000). Learning theories have undergone significant changes over the last three decades in terms of both expected learning outcomes and the centrality of learning activities to bring about intended results (Bransford et al., 2000; Cognition and Technology Group at Vanderbilt, 1996; Grabinger, 1996; Greeno, Collins, & Resnick, 1996). One of the changes is the shift in focus from developing basic skills to becoming lifelong learners and problem solvers (Cognition and Technology Group at Vanderbilt, 1996). Another is the emphasis on what students do rather than what the teacher does and the alignment of the learning activities to learning outcomes.

In the context of technology use, alignment relates to who uses the tools in the teaching learning process and for what purposes. Schmid et al. (2009) reported that use of computer related technologies as cognitive tools resulted in significantly higher measures of student achievement compared to using the technologies as presentation tools. On the other hand, in university classrooms where laptops were provided to students without explicit purposes and learning activities, researchers found no significant difference in student achievement scores (Wurst, Smarkola, & Gaffney, 2008) and, in some cases, laptop use in classroom was found to be “distractive” to both the users and fellow students in the class (Fried, 2008). A logical conclusion can thus be drawn that computers need to be included in the context as resources that students learn *with* and be used as cognitive tools that provide the opportunity for students' active engagement and deep learning (Kozma, 1987; Salomon et al., 1991).

Conclusion and future research

The main point of this paper has been to emphasize the conceptualization of effective teaching in university setting as the design of learning environments that provide the conditions for students' active engagement. Such environments may also involve the use of computer related technologies for student learning. More specifically, it argues that there is both theoretical and empirical support for the benefits of using computer technologies for supporting student learning, although the empirical evidence comes largely from laboratory studies rather than natural learning environments. Application of these findings and use of technological affordances can be better achieved through enhanced view of cognitive tools that includes the learning activity and the agency of the learner. Technological affordances represent the perceived and actual functional properties of the tools that determine the way the tools are appropriated (Pea, 1993). Learner agency relates to the ability of the learner to operate independently, to exercise personal influence on the tools and processes, and to meaningfully shape their responsiveness to constraints (Bandura, 2001; Emirbayer & Mische, 1998). An important element of agency is intentionality, deliberate planning and "commitment" (Bandura, 2001) to use the tools for learning purposes.

Emphasizing learner agency in learning with computer-related tools implies a shift from planning teaching activities to design of learning environments that take into account different aspects of learning and student engagement including contextualization of content, use of educational rationale, appropriation of contextual resources including computers, considering cognitive and social aspects of learning, and use of learner and learning-centered approaches to teaching. An argument is made for the use of computer-based cognitive tools in natural learning environments with the emphasis that the value of these tools comes from aligning the affordance of the tools with educational rationale and learner agency. Judicious use of the tools necessitates understanding the reciprocal relationship between what tools can do to learners and what learners can do with the tools.

Conceiving effective teaching as designing learning environments that involve use of computers as learning tools leads to related research projects—the first of which is understanding professors' conceptions of effective teaching and whether or not the conceptions reflect elements of rich learning environments mentioned above and constructivist perspectives to teaching and learning. Saroyan et al. (2004) suggested that having sophisticated conception of teaching is a precursor for adopting learning-centered approaches to teaching. In a related effort, it will be necessary to determine the context-specific or context general nature of professors' conceptions. Given that learning environments that involve use of computer technologies provide special opportunities for student engagement, information on how professors perceive these environments and appropriate the tools provide insight for design of learning environments as well as faculty development programs.

Another area of research relates to the design and assessment of learning environments. Different universities invest hugely on acquisition of computers and design of active learning classrooms. Learning environments are much more than physical facilities. The extent to which these environments facilitate student learning and provide opportunity for better teaching needs to be examined. One approach can be developing instruments for assessing the nature and extent of student engagement while they learn in these rich learning environments.

Still another area, related to the first, is understanding the dilemmas professors encounter when they design their teaching and articulate their conceptions of teaching while teaching in these classrooms. Conceptual and pedagogical dilemmas of k-12 teachers related to understanding and implementing constructivist teaching and learning are well documented in the literature (e.g. Windschitl, 2002). There is no reason to believe the situation is different in university contexts.

Bridging Manuscript

In Manuscript 1, it is established that in order to benefit from the potential that computer related tools afford, effective teaching needs to be conceptualized as context-oriented design of learning environments based on learner and learning-centered approaches as well as involving cognitive and social engagement of students. The logical continuation in the research is examining whether or not professors who teach in technology rich classrooms have such a conception of teaching. Researchers have investigated professors' conceptions of (effective) teaching and have reported a range of conceptions (Carnell, 2007; Kember, 1997; Kember & Kwan, 2000; Samuelowicz & Bain, 1992; Saroyan et al., 2009). Studies have also suggested that conceptions of teaching influence teaching approaches and strategies (Saroyan et al., 2004; Trigwell & Prosser, 1996b) and that conceptions are relational in that their activation may be facilitated by a specific context (Entwistle et al., 2000; Samuelowicz & Bain, 1992). For example, Samuelowicz and Bain (1992) reported that professors' conceptions of teaching as supporting student learning was limited only to graduate level teaching.

In the wider technology implementation literature, the way users perceive the value of the technology—"perceived usefulness", is reported to be a determining variable for technology appropriation (Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003). Given the considerable role professors play in relation to the design of the classroom environment, their perception of effective teaching and their subsequent design of learning activities are likely to influence whether or not students utilize computers as learning tools and engage both cognitively and socially with the learning material.

How professors view effective teaching in relation to a course and technology rich contexts has not been investigated. Also it is not clear how professors' conceptions of effective teaching relate to their use of computer technologies in their teaching. The research reported in manuscript 2 examined the context specificity of conceptions and their relationship to perceived use of computers in university teaching.

The study in Manuscript 2 used semi-structured interviews to capture variations in conceptions of teaching applied to the course professors were teaching in active learning classrooms. It also examines the relationship between professors' conceptions and their perceived use of computers in their teaching in the specific context of Active Learning Classrooms. Considering recent efforts in university campuses that emphasize the importance of designing active learning environments for student engagement and personal development (Shulman, 2002), the research will be of importance for teaching practices and faculty development efforts.

Chapter III: Manuscript 2

Professors' Conceptions of Effective Teaching and the Role of Computers in Technology Rich Classrooms

Gebre, E., Saroyan, A. & Aulls, M. (under revision). Effective university teaching in technology rich classrooms: The role of conceptions and computers. *Educational Technology Research and Development*.

Abstract

This paper examined course and context specific nature of professors' conceptions of effective teaching and how the conceptions related to perceived use of computers in technology rich classrooms. We interviewed 13 professors who were teaching in active learning classrooms in winter 2011 in a large research university in Canada. The interview captured views of effective teaching, expected learning outcomes for students, instructional strategies, and the role participants saw for computers in their teaching. Analysis of the interview transcripts using open-coding and between case comparisons resulted in three conceptions of effective teaching—transmitting knowledge, engaging students, and developing learning independence/self-reliance. Perceived use of computers was found to be related to conceptions of effective teaching. Professors whose conception of effective teaching focused on developing learning independence used computers as tools for students' learning; those with a transmitting knowledge conception

considered computers as a means of accessing or presenting information. Results have implications for research and faculty development.

Introduction

Jacques Steinberg's article in The New York Times in which he wrote that "more professors give out hand-held devices to monitor students and engage them" (Steinberg, 2010, November 15) and Parslow's (2010) related commentary entitled "When innovation detracts from good teaching" highlight an ongoing debate concerning the role of technology in general and computers in particular in university teaching and learning. The debate brings to fore questions concerning why and how professors use computer related technologies in their teaching and whether the nature of this use has anything to do with their views of effective teaching. In this paper we attempt to address these questions.

Serious conversations that delve into the value added dimension of computer related technologies in education largely attribute the value to the design of learning activities and environments rather than to the presence or special features of the technological tools, *per se*. The literature informs us that learning activities need to be designed in ways that elicit students' active engagement, requiring the use of tools in ways that result in a type of learning not attainable otherwise (Jonassen, 2000; Jonassen & Reeves, 1996; Kim & Reeves, 2007). Effective design of learning activities are typically theoretically grounded and aligned with constructivist and learning-centered perspective to teaching (Hannafin et al., 1997; Hannafin & Rieber, 1989; Salomon, 2000).

We know from the literature on university teaching that conceptions of teaching influence intentions and instructional strategies (Entwistle & Walker, 2000; Trigwell et al., 1994). In other words, professors' adoption of learning-centered teaching approaches and strategies will depend on whether their conceptions of teaching include a view of teaching as facilitating learning rather than transmitting information (Ramsden, 2003). This literature, however, does not provide insight into whether there is a relationship between conceptions of effective teaching and the selection or use of computer related tools in teaching. This gap in our understanding can be attributed to the independent evolution of two bodies of literature: conceptions of effective teaching and use of computers in teaching. Research on effective teaching has typically focussed on elaborating and understanding professors' conceptions of teaching and determining traits and activities attributed to effective professors. Likewise, empirical and meta-analytic research on the use of computers in teaching have largely focused on comparing teaching methods with or without different computer tools with the purpose of delineating "effects" of computers on student achievement (Fried, 2008; Schmid et al., 2009; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011; Wurst et al., 2008). Almost in all cases, the educational rationale behind the use of computer related tools and the design of teaching and learning activities within this medium have been, at best, implicit and often unexplored.

In a climate where there is increasing pressure on professors and institutions to improve the quality of teaching and to use modern technologies in ways that meaningfully support student learning, research that examines professors' use of computers in teaching in light of their conceptions of effective teaching is timely.

Relevant research can provide useful input for organizational decision-making involving technology implementation as well as faculty development programs. Moreover, findings can elucidate best practices in teaching with technology.

As part of a research project that investigates the use of computers in technology rich classrooms from the perspectives of professors and students, the study reported in this paper addressed three questions: a) What is effective teaching for professors who teach in a technology rich classroom? b) What role do professors see for computer related tools in enacting their view of effective teaching? c) In what ways are professors' conceptions of effective teaching related to the perceived role and use of computers?

Computers in University Teaching

Questions related to effective use of computer related technologies in university teaching and learning are still relevant despite more than three decades of research on computers and their use in university classrooms (Schmid et al., 2009; Selwyn, 2007). A persistent criticism voiced in this literature throughout the years has been that computers reinforce traditional methods of teaching instead of promoting more learning-oriented teaching approaches and strategies (Carpenter & Tait, 2001; Collis & van der Wende, 2002; Cuban, 2001; Kling, 1986; Selwyn, 2007). More than a decade ago, Cuban (2001) described the situation of computer use in US universities as "new technologies in old universities" (p. 99), implying that new tools are used to teach in the same old ways. Carpenter and Tait (2001) expressed a similar concern about Australian universities, asserting that technology is allowing "traditional lecturers to become more effectively traditional" (p. 201). An international comparative survey of the use of technology in higher education (Collis & van der Wende, 2002) concluded that information and communication technology (ICT) use in the form of email, word-processing, power point, and the web has become common but has not radically affected the teaching and learning process.

More, recently Schmid et al. (2009) have pointed out that the effect of computer use in teaching and learning is "differential" due to conditions under which the tools are used and the corresponding teaching strategies determine whether or not the tools are supporting student learning. For example, when used as cognitive tools—tools that assist students during thinking, problem solving, and learning — rather than as presentation aids, computers can improve student learning (Jonassen, 2000, 2003; Jonassen & Reeves, 1996). Schmid et al. (2009) have also arrived at a similar conclusion in their meta-analytic study of the effect of technology on students' achievement in higher education. They conclude that when computers are used as cognitive tools, students' performance as measured by achievement scores is significantly higher compared to when computers are used as presentation tools. If these assertions are true, a question that begs an answer is why do professors not use these technological tools in ways that can actually facilitate student learning? This question is not addressed in the broader literature on computers in education nor in the more recent literature on computers as cognitive tools. Indeed, this latter body of work is silent in this regard as the teaching agent is typically invisible in any elaboration of the deployed technology appropriation. Instead, the focus is on student learning resulting from the use of computers (Kim & Reeves, 2007).

Effective Teaching as a Context-Specific Construct

Decades ago, Cameron (1986) argued that "effectiveness" in higher education institutions is problem-driven rather than theory-driven. Effectiveness is best described as fit for purpose and as such, no single theory or criterion can explain or represent effectiveness as definitions and measures of the construct vary from one context and/or constituent to the other. Various researchers have questioned the universality as well as practical applicability of effective university teaching representations (Berk, 2005; Carpenter & Tait, 2001; Devlin & Samarawickrema, 2010; Eley, 2006; Kane et al., 2002). Berk (2005) has asserted that from humanistic perspective, effective teaching could mean creating democratic classroom environments and positive relationships, while from a "scientific" perspective, it could mean "measuring" processes and products of teaching. Criticizing the general nature of effective teaching representations in university policies and promotion criteria, Carpenter and Tait (2001) have iterated that "…monolithic understandings of good teaching, …irrespective of context, are often inappropriate, ineffective and iniquitous" (p. 191). This is because teaching effectiveness could vary depending on the subject matter, level of the learners, views of the professor, and other context related issues. In support of this view, Devlin and Samarawickrema (2010) have suggested that meeting the requirements of the teaching and learning context is a central aspect of effective university teaching.

Context is a frame that surrounds the event under consideration and includes two major components—"a focal event and the field of action within which that event is embedded" (Duranti & Goodwin, 1992, p. 3). In this study, the focal event is teaching and learning with technology and the field of action is the classroom situation or environmental set up. Context is thus the weaving together of social, physical, spatial, and psychological aspects in a way that helps the particularization of meaning and provides coherence for the teaching and learning (Gilbert, 2006; Van Oers, 1998). Van Oers (1998) described context as “meaningful situation”—a situation that makes sense in relation to the focal event being undertaken; and it has four dimensions (Duranti & Goodwin, 1992; Gilbert, 2006). The first is the setting that includes the social and spatial framework within which the teaching and learning takes place. The second is the behavioral environment in which students participate and engage in a way that they freely express their views, respect and understand the perspectives of others, and learn from each other. The third dimension is the tools that learners use in a manner that contextualizes their learning by lending the expertise of previous users and designers. Tools also help learners in relating concepts, externalizing their thoughts, and creating representations. The last dimension is extra-situational context that extends beyond but relates to the current situation; for example, how previous knowledge or background and possible future application shape or interact with the current teaching and learning situation.

Active Learning Classroom as a Context

Active learning has two major components. The first is students’ active involvement in decisions related to their learning such as goal setting, choosing activities and projects, checking their progress, and reflecting on their performance (Simons, 1997). The second relates to mindfulness in the learning process (Salomon & Globerson, 1987) and dealing with challenging tasks that require use of mental abilities in the learning process (Simons, 1997). These two components which are considered to be facilitators of meaningful learning and transfer necessitate the design of learning environments in a way that cultivate and allow students' active participation.

Active learning classrooms (ALC) are instances of rich environments for active learning (REAL) (Grabinger, 1996). They are often established with the purpose of integrating technology, facilitating active student learning, and improving teaching practices (Pundak & Rozner, 2008). Rich learning environments are comprehensive systems of learning and instruction that facilitate active as well as collaborative engagement of students in authentic and generative learning activities with the goal of integrating or constructing knowledge and achieving higher level thinking and problem solving capabilities (Grabinger, 1996; Kovalchick & Dawson, 2004). Although Grabinger (1996) contends that rich environments for active learning do not necessarily require computer related technologies, computers can be powerful tools that can facilitate active learning and constructivist oriented instruction (Dori & Belcher, 2005; Jonassen, 2000, 2003; Kim & Reeves, 2007).

Various universities in North America have introduced active learning classrooms to enhance the learning experiences of students. The Technology Enabled Active Learning (TEAL) at MIT, the Student-Centered Active Learning Environment for Undergraduate Programs (Scale-UP) at North Carolina State University, and the Active Learning Classroom (ALC) project at University of Minnesota are all examples of active learning classrooms (Dori & Belcher, 2005). Ideally, these classrooms provide the major components of context mentioned above. The social and spatial dimension results from the design of the classrooms as well as from the round or long tables that are often occupied by a number of students thereby facilitating discussion at table or classroom levels. In some case, professor podiums are at the center for more participatory teaching, there are extension rooms for breakout groups, and chairs are flexible for easy regrouping. Computers are available on the tables together with screen sharing facilities. In general, active learning classrooms afford professors with the context to design learning environments that use computers as learning tools. Students can use the tools to represent their knowledge, analyse and synthesize information, examine alternative hypothesis, and collaborate with others. They can also learn how to use the tools for independent learning. That is, learners understand the two way relationship between how to learn with the tools and how to use the tools.

However, as it is suggested in the broader technology implementation literature, the consistency and quality of use of such innovative facilities is a function of its alignment with the values and perceptions of the users (Klein & Sorra, 1996). In the university context, users would include professors and students. "Perceived usefulness"—the extent to which users believe a given technology helps them to perform the job they do and achieve their intended goals—is considered to be a fundamentally determining variable for successful technology appropriation (Davis, 1989; Venkatesh et al., 2003). In the context of university teaching this translates into how professors perceive what teaching in such context entails and the role computer-related tools can play in helping them achieve effective teaching and student learning.

One of the concerns about the existing literature on conceptions of university teaching is that descriptions are generated from answers to general questions such as "what is teaching for you?" Such questions are often not tied to a specific course or teaching context or a specific group of students involved in the teaching process. Not surprisingly, responses to such questions reflect general views and omit the nuances that are best understood when the contexts are specific. The context of teaching may differ in terms of student diversity, institutional expectation and support, and technological facilities, among other things (Devlin & Samarawickrema, 2010). It is therefore imperative that we consider these contextual factors in conceptualizing as well as assessing effective university teaching.

Eley (2006) has pointed out another dimension of the same concern. He has argued that because of the nature of questions asked, reported conceptions could be broad opinions or "*post hoc* reflections" on past experience and may have little to do with actual classroom practices or with specific plans and decisions related to teaching in a specific context (Eley, 2006; Kane et al., 2002).

In this study, we used the context of active learning classrooms to investigate professors' conceptions of effective teaching in relation to a specific course they were teaching in this classroom. Furthermore, we explored how their conceptions of effective teaching relate to their perceived use of computers in teaching in the context and course.

Methods

This study employed a multiple case study approach (Yin, 2003) with the purpose of understanding technology use in relation to conceptions of effective teaching. Stake (1995) refers to these genre as instrumental case studies, carried out for the purpose of understanding a wider phenomenon; in this case, the use of computers for teaching and active learning. The case in this study is a course taught in an active learning classroom.

Through this course we try to understand professor's conceptions and perceived role and use of computer tools in teaching.

Context and Participants

The research site was a large research-intensive university in Eastern Canada. In 2009, the University established its first two active learning classrooms to encourage interaction between students and faculty, promote active and collaborative learning, enrich educational experiences, and provide a pedagogically supportive environment. One of the rooms (Room 1) has the capacity to accommodate 72 students at eight large round tables – each with nine seats, two computers with screen sharing facilities, a microphone, and connection slots for laptops. The professor's podium is located in the center of the room with facilities for accessing each computer screen in the room and displaying it for class discussion when necessary. The second room (Room 2) has a capacity of 38 students accommodated at six long tables with a one-to-one student-computer ratio. The professor's podium is at the corner of the room and, like Room 1, the room has a PC with screen access/sharing facilities. Both rooms were converted from their traditional design to accommodate the technological infrastructure and to support collaboration and interaction. .

Excluding computer science courses and courses taught by graduate students, nine courses were scheduled in Room 1 and 10 in Room 2 for the 2011 winter term. With the exception of two professors who were already familiar with the research project, we contacted the remaining 17 professors by phone and/or email, explained the purpose of the research, and invited them to participate in the research. Thirteen professors (68% of those scheduled to teach in the active learning classrooms), 5 female and 8 male, consented to participate. Eleven of these held positions ranging from assistant professor to professor; the other two were faculty lecturers[1]. The participants' teaching experiences ranged from 2 to 34 years. When classes actually began, two professors (one from each room) opted out of the active learning classrooms and continued the delivery of their course in traditional classrooms but they continued their participation in the study. Of those who continued to teach in the active learning classrooms until the end of the term, only two were first time users of the facilities.

The courses taught by participating professors were in Philosophy (1), Physics (1), Law (1), English as a second language (2), Geography (6), Electrical and computer engineering (1), and Management (1). The high participation of geography professors is explained by the fact that Room 2 is housed within the facilities of the Geography Department and professors and students of that Department are primary users of the room. Four of the courses (management, one of the language courses, and two of the geography courses) were graduate level; the rest were undergraduate courses.

Data Sources and Analysis

Data from professors were collected using semi-structured interviews that took place in their respective offices except in two cases where the interviews were conducted in the office of the principal researcher for greater convenience. Interviews were based on 14 questions and lasted 50 minutes on average and were audio-recorded. Interview questions focused on professors' views of effective teaching in this specific context and course, expected outcomes for students, their instructional strategies, the role they saw for computers in their teaching and in realizing their instructional goals, the type of

[1] *A faculty lecturer is a non-tenure track position.*

applications they used, and other related issues (please see Appendix A) —all in relation to the course they were teaching in that particular term and classroom. The purpose of the interview was to understand professors' espoused conceptions of effective teaching for the specific course, their instructional strategies to enact effective teaching, and the role they attributed to computers in the process.

All interviews were transcribed verbatim. Professors' descriptions of effective teaching, expected learning outcomes, and instructional strategies were first considered for analysis. The descriptions were then analyzed using a holistic inductive approach (Patton, 1982) and a constant comparison method (Strauss & Corbin, 1998). First, professors' descriptions were segmented into "units of meaning" (Pratt, 1992). Units of meaning are segments that contain part of a sentence, a sentence, or more than one sentence representing an idea or a single meaning. Different researchers refer to such segments by different names including "topics and related comments" (Aulls, 2004; Aulls & Ibrahim, 2012) and "idea units" (Butterworth, 1975; Krull, Oras, & Pikksaar, 2010; Stinson, Milbrath, Reidbord, & Bucci, 1994). Butterworth (1975) suggested that there is no structural implication or restriction on the size of the idea unit. The following are examples of such segments or units of meaning from descriptions of participating professors.

> "I think at the upper level it is not just about the professor going up there and talking about things. It is about getting students to think and the chance to engage. I think it is a key, student engagement, really" (*effective teaching*)

> "In this case, it is electromagnetic waves and so they have to understand all the concepts related to electromagnetic waves or all the list of topics. So, they should understand all the topics." *(Expected outcome)*

> "...we do them, we do the activities, and we see where the problems are, where the difficulties are, and then we try to use principles or examples to illuminate what we could do" *(Instructional strategies)*

It is worth noting that professors' descriptions of their views of effective teaching, their expected learning outcomes and their instructional strategies were not clearly different at times. As a result, there were segments from one description that were similar in meaning to segments in other descriptions. When this happened, they were coded together. The distinction between the three sets of a professor's description was less important than the alignment between them and the holistic picture they represent about that professor's conceptions of effective teaching.

We then applied open coding and constant comparison to the units of meaning mainly within each category of effective teaching, expected outcomes, and instructional strategies. That is, after reading the first segment (unit of meaning) of effective teaching, we created a provisional category. Subsequent segments were compared to existing categories. When the new segment was the same in meaning as the existing category, it was grouped together; if not, a new category was created (Samuelowicz & Bain, 1992). This required considerable iteration between units of meaning, generated categories, and original transcripts to represent views of professors as correctly as possible. This process was repeated for descriptions of learning outcomes and instructional strategies. The coding was done by the first author. For reliability, a professor emeritus who is an established qualitative researcher was briefed about the coding procedure and asked to code the responses of nine professors on views of effective teaching. There was 89% agreement between the two independent coders. The codes led to generating subordinate categories as described in the results section. The analysis also helped us examine the consistency of responses within a case and to compare responses between cases. Finally, professors' descriptions of the role of computers and their perceived use of the tools in their teaching were described.

Results

Effective Teaching

Professors were asked the question "what is effective teaching for you in this course?" In their response professors made reference to both outcome and process aspects of teaching. Outcome related descriptions emphasized the end product such as "how much students understand" (P004) or "students' development as good teachers" (P013). Process-related descriptions pertained to activities that professors and/or students engage in such as "giving instruction and examples of application" (P009). Some professors made reference to both aspects while others referred to only one. We compared segments of professors' descriptions in terms of their meaning and the purposes they intended to serve. One of the observed variations was in terms of professors' intentions to bring about student learning and the related activities of teaching. Intentions, in this context, were defined in terms of "representations of future courses of action" (Bandura, 2001, p. 6) and reasons for professors' adoption of a given teaching strategy (Trigwell & Prosser, 1996b). Intentionality is the "essence of teaching" (Garrison & Macmillan, 1994, p.386).

Some professors described these intentions as the "most important thing" (P001) in their teaching.

Professors' descriptions of effective teaching were then grouped into three categories based on professors' expressed intentions and whether or not the emphasis in the description was on teacher or student related activities. These three categories were effective teaching as teacher-centered activity, engagement-centered activity, and learning and development-centered activity. Table 1 presents the three categories. To triangulate and as a means of obtaining additional information about their views of effective teaching, professors were also asked what they expected their students to learn from the course—the expected learning outcome. Responses were compared in the same way as the descriptions of effective teaching but based on the nature of learning outcomes. The three categories of learning outcomes were subject matter (content) understanding, skills development, and learning independence. Table 2 presents these categories of learning outcomes. Descriptions of effective teaching and learning outcomes are discussed together below.

There were noted variations in categories of effective teaching descriptions and expected outcomes. In category 1 whether professors described effective teaching in terms of a process (e.g., P009) or a product (e.g., P001, P004), they emphasized students' learning of content or understanding of subject matter. Views captured in this category suggested that there is pre-planned content and structure of the subject matter that learners should understand. Thus, the meaning of effective teaching captured in this category, appears to be related to organizing and explaining pre-determined content in a way that helps students' understanding. Also, effective teaching descriptions relate to teacher-related activities (e.g., P001, P009) and the amount/quantity of student learning (P004). Within this context, the expected learning outcome for students at the end of the course is developing subject matter knowledge. The following excerpts are examples from this first category.

> I really aim that [the subject] should be clear to them. What they are reading should become clear to them through my teaching and what I actually say should be clear to the students. So that seems to me the single most important thing (P001).
>
> It is how much the students understand and get out of it and that is the sort of outcome… Students should learn as much as possible.
>
> I think, …for that kind of course [effective teaching] would be giving instructions to the students on particular concept, and, then, giving examples of application. And, having students doing examples of that on their own would be good (P009).

Descriptions in category 2 primarily focus on engaging students in the learning process and with the course materials. Students are expected to acquire subject matter knowledge but through participation and interaction rather than through the professor's presentation. Engaging students takes different forms such as students making presentations and participating in class discussions; professors considering students' needs and backgrounds, creating a dynamic classroom environment, and encouraging student participation. As shown in Table 2, beyond understanding the subject matter, professors expect their students to develop skills such as assessing impact and criticising debates (P002) and teamwork or collaboration (P003).

These descriptions and outcomes differ from those in Category 1 in the sense that the purpose of effective teaching extends beyond making the content clear for students. Considering the phrases used by participating professors, "engaging students" (P002), "encouraging participation", and "empowering students" (P007), one can say that these descriptions are more process and interaction oriented where students have relatively more control of their learning. Expected outcomes involve subject matter knowledge as well as the development of social and cognitive skills. The following excerpts are examples of this category.

Table 1

Descriptions of Effective Teaching

Prof.	Category 1 (Teacher-centered)	Category 2 (Engagement-centered)	Category 3 (Learning and development-centered)
P001	Clarity of subject to students; students' developing reading & writing skills [on the subject]		
P002		Engaging students; getting them to think, discuss, and make presentations	
P003	Providing theoretical material and real life examples	Facilitating student participation, stimulating discussion; considering their backgrounds	
P004	How much students understand and get out of it. They should learn as much as possible		
P005		Students need to be engaged with the material, have hands on experience, engage in discussion, make presentation	
P006			Students learning through practice; work as independently as possible; solve their own problems

P007		Generating debate, encouraging participation, empowering students	
P008			Students using tools to address sustainability issues; interpretation of results
P009	Giving instruction and examples of application on particular concept		
P010		Creating dynamic class environments; understanding Challenges students run into; following their progress	Students working on modelling; providing instant feedback when they face with problems;
P011			Developing learning independence, strategies, and metacognitive awareness
P012		Creating dynamic environment; engaging students, team teaching	
P013			Helping students develop as good teachers; developing their self-reliance, cultivating critical insight

Table 2

Expected Learning Outcomes

Prof.	Category 1 (Subject matter understanding)	Category 2 (Skills development)	Category 3 (Strategies and learning independence)
001	Knowledge about [the subject]; Writing and reading clearly [about the subject]		
002		Understanding key debates and policies on climate change; assessing impacts of climate change; developing skills to get involved in discussions	
003		Understanding of theories and their impact in organizations; effective team work, management of self in organizations	
004	Understanding defined content and aspects of the subject; solving		

	exercises		
005		Calibrating and analysing data; proficiency in software tools (ENVI & Math lab)	
006		Proficiency in the software	Dealing with technical solutions to geography problems; learning independence; approaching and solving problems
*007**			
008			Understanding logic and performing conceptual analysis; understanding what goes on behind the software; selection and use of tools
009	Developing knowledge of mathematical tools, the main concepts		
010			Building models; ways of approaching problems, systems thinking; applying models to their research interest
011			Strategies; better sense of their own

		abilities; learning independence
012	Writing equations, solving exercises using models	
013		Way of looking at the development of a syllabus, materials, and teaching techniques that all work together; having competencies required by Ministry of Education

**This outcome statement was not clear enough to be coded.*

> It is not just about the professor going up there and talking about things. It is about getting students to think and the chance to engage. …I break them into groups and… half the group will have one set of readings and half the group will have the second set of readings and then for like 20 minutes the group will break out and teach each other… I think it is a key, student engagement, really (P002).

> [Effective teaching] is team teaching …to create the dynamics in the class where there is more participation, more interaction between the teacher and the students, because it is more about getting the students engaged (P012).

> So, the students need to be engaged with the material, I would like them to have hands on experience with some of the methods they are learning. [Students] actually learn the material when they can do it for themselves (P005)

The third Category consists of descriptions of effective teaching that extend to students' holistic development (P013), the ability to work independently (P006, P011, P013), and their use of tools in their field (P008). Professors in this category view effective teaching as creating opportunities for students to work on defining problems, modelling solutions, determining the utility of tools, and interpreting results. Essentially, the primary goal is developing students' independence and self-reliance in learning. Learners' ability to develop strategies for understanding and representing problems or for interpreting the world is emphasized. This is also mirrored in the descriptions of expected learning outcomes as professors expect their students to deal with technical solutions (P006), understand the logic behind what the software does (P008), develop ways of approaching problems, and produce artifacts in the form of models and teaching materials (P010, P011, P013). Professors (e.g., P010 and P013) also maintain that as it is not possible to prepare students for every possible scenario in the work place or real life, students need to learn ways of approaching and addressing new problems. The following excerpts include examples from Category 3.

> My effective teaching is helping the students develop as good teachers…. Some of the end results that we want are things like self reliance, they should be able to depend on themselves,… to get through a course, to be able to prepare materials, to be able to assess students, and we cannot prepare people for every single eventuality (P013)

> I approach the course in a quite loose way. … I don't explain it all. I leave them with the problem to some degree and I then am around all the time with two TAs and we support rather than show them everything and just ask them to repeat. So they have to remain in my eyes a little bit in the dark, do it themselves, get a bit frustrated, solve it, solve it with their neighbours, and I think they learn much more by doing that (P006)

> …for me it is very important that students develop strategies and that they develop their meta-cognitive awareness about writing so they become independent with their learning. They are not always going to… and they shouldn't have a language teacher at their side all the time. So, I am hoping that they will learn ways to become more independent with their writing (P011)

Considering professors' descriptions of effective teaching and expected learning outcomes as presented in Table 1 and Table 2, we generated three categories for professors' conceptions of effective teaching—effective teaching as "knowledge transmission" (Category 1), as "student engagement" (Category 2), and as "developing learning independence/self reliance" for students (Category 3). The categories are not mutually exclusive in the sense that a higher category (e.g., 3) may include traces of descriptions of a previous category (e.g., 1 or 2). This suggests to us that there is a hierarchical relationship between the categories.

In the subsequent sections we compare these three conceptions in terms of instructional strategies and perceived role and/or use of computer related technology in their teaching and learning

Instructional Strategies

Instructional strategies consist of a series of decisions and plans and varieties of related teaching activities that are aimed at achieving intended outcomes (Dick, Carey, & Carey, 2001; Jonassen, Grabinger, & Harris, 1991). Jonassen et al. (1991) have made a distinction between instructional strategies and instructional tactics as they consider the latter to be the "specific means" for implementing strategies. In this paper, we use the term instructional strategy more broadly to include specific activities—without differentiating between strategies and tactics. We examined the instructional strategies used by participating professors for two purposes. The first was to check how the strategies they used differed in relation to their views of effective teaching and whether there was a relational pattern between strategy and teaching conceptions. The second was to see how instructional strategies related to the way professors' perceived the role of computers in their teaching. Accordingly, professors were asked to describe the type of strategies they use or what they do to enact their views of effective teaching and thereby achieve intended learning outcomes.

Responses were segmented and compared to each other and coded based on the extent of control the specified strategy gives to learners. Learner control in this case is the extent to which the student can take steps independently or can make decisions about learning of the topic or the course and in so doing, develop self regulated learning skills (Merrill, 1987). Each segment in the description of instructional strategy expressed by professors was coded as to whether it reflects more "teacher control", "interaction-focused", or "student control". When professors mentioned more than one strategy, for example, lecture and group discussion, each was coded separately. The result of the coding is shown in Table 3.

As can be seen in Table 3, professors in category 1 described their strategies in terms of lectures, question and answer sessions, in-class exercises, and assignments. They also reported preparing clear plans for lectures and related activities, providing clear instructions for assignments, making notes available to students, and presenting lectures with coherence and clarity. It appears that these strategies were intended to help students understand the defined content by providing clear structure. Descriptions largely focussed on what the professors do during preparation and presentation rather than what the students do during the learning process. The following excerpts are provided as elaboration.

> I always have a plan for the lecture if it is a lecture, if it is not a lecture for the different activities that we are going to do… I stop regularly and ask if they have any questions to make sure that what I have said is clear to them… I am requiring them to bring in discussion questions from the reading and I have given them instruction on what a discussion question should look like… To get them to write clearly, I have assignments that are very short again with very specific instructions (P001)

> So, my impression is that I want to use lectures… [Students] can ask question, we do exercises together. I ask a lot of questions and the idea that they keep attention. I have all the notes on the web. I use that as the basis and I use the web to have my notes on and it is accessible with password which they get through WebCT. So, they can access the notes anytime… I use clickers in class, every class I have four clicker questions (P004)

> You need to have a coherent story. …this concept that you give, you need to introduce it in a coherent fashion. It is like telling a story, and you need to …go one step at a time until you complete and you go around this concept, …you give it entirely step by step …it needs to make a nice story at the end (P009).

Table 3

Instructional strategies

Prof.	Category 1 (Teacher control)	Category 2 (participatory)	Category 3 (Student control)
P001	Having clear plan; asking questions; requiring discussion questions; giving assignments with specific instructions		
P002		Group projects; student presentation with question & answer, role playing (debates)	
P003		Using cases; providing support while they work on it, group projects & presentations.	
P005	Changing assessment to open-ended questions	Reading and presentation with Q & A; lab assignments, hands on exercise	
P004	Putting all notes on WebCT; using clicker questions; using applets	In-class group problem solving	

P006	Lecture	Group exercises, class interaction	Loose approach to teaching, more independent work; supporting with my TA; letting them work on their own projects
P007		Class exercises, group discussion	
P009	Having coherent story; presenting one concept at a time; getting their attention		
P010		Creating dynamic environment at table and class level; students working on model building exercises	
P008	(Guest) lectures	discussion; student presentation, in-class group exercises	Independent lab exercises; supporting lab efforts; summarization of articles, group projects
P011			Working on strategies and ways of learning; using databases
P012	Lecture	Being approachable; encouraging	

	questions; team teaching; creating dynamic environment	
P013	Doing the activities in class together; providing feedback	Students developing materials; asking them to evaluate their work, to redo, and to reflect

In Category 2, the instructional strategies identified by professors were participatory and focussed on students' engagement with course materials and their interaction with each other as well as with the professor. This included reading assigned materials and making presentations about it often followed by question and answer sessions. The other common strategy was group work that involved working on problems in and out of class and making presentations. Professors also used cases where students sitting around the same table discussed and shared ideas. This strategy fostered an open and democratic classroom environment where students freely interacted and expressed their ideas and points of views.

> [Students] spend two hours in a seminar format every week where they discuss papers and two students present and then they discuss the papers (P005).

> … we have a simulated United Nations climate change convention which takes five classes and the students break up into groups of five. Each group has a country and we simulate a climate change negotiation like what happen through the United Nations… So, they have to make a presentation on that stand point on climate change policy. They are then asked questions by other groups (P002)

> The classroom is set up with round tables and chairs so they are very used to discussion. They are also very open to ask questions… And then we move on to our activity. During activity, I generally flow from table to table; check times, if there are any questions (P003)

Professors in category 3 reported using direct instruction strategies such as lecture to a certain degree; however, they predominantly employed strategies that involved practical exercises, problem definition, independent work, and model building. They reported relying less on straight lecturing, rather they allowed students to choose their own projects and define the parameters by themselves, and work on summarizing articles.

> …for each module, they work on lab assignments… We essentially help them quite actively. It is not an exam it is an assignment and so we're teaching skills on the fly in activity way… The other is for each of the journal articles, they write summaries and what they learned from the papers…For the group project, they will have to design it for themselves,...design the whole course. The idea is that they will have to think about how to set boundaries for their problem (P008).

> We look at strategies, ways of learning and really helping [students] in their metacognitive awareness. Just as a concrete example, one of the things that I have been trying to get them …to do is when they read their academic articles they should be reading a minimum of two times—once for content because they have to understand…and once for form to see how things are written. [We employ] lots of strategies and a better sense of their own abilities to have themselves learn, empowerment; that they can do a lot for themselves with their learning (P011).

> There are two ways that I do… one [goes] from the problem to the activity and the other from the activity to the problem. I think it is partly because they have to put themselves in a kind of metacognitive state, you know, when they do this. So, they need to be able to feel what the problems are (P013).

The Role of Computers in Effective Teaching

Professors were asked about the role they perceive for computers in enacting their conceptions of effective teaching and the type of related applications they use or they expect their students to use in their course. Professors in the knowledge transmission category used computers primarily for making presentations and accessing information. For example, Professor 001 stated that "because there is a document camera I can have the plan of the lecture up and then I can put up passages from the text and ask them to think …carefully about the particularities of the passage." Professor 004 who used animations (physics applets) from the Internet stated: "I use [computer] just as a way to present stuff like lecture notes and articles…again for the clickers I need the computer".

Professor 009 expressed the role of computers in her teaching as “maybe [for] animations. It will be a good thing if you put animations in your power point slides. I do that sometimes”.

Responses of professors in the student engagement category varied based on two views of student engagement. One view, held by three professors, related effective teaching to social aspects of student engagement in terms of discussions, interactions, and communication. These professors viewed computers to have a limited role in either their teaching or students’ learning. Professor 003 stated her preference for round tables in the room over the computers: “If I had a choice between the computers in there and the round tables, I would throw out the computers and keep the round tables… because of the interaction that they encourage”. Another professor in the same group stated: “I always found [computers] kind of get in the way. I don’t want my students in front of computers, I want them thinking about the things; I want getting together in little groups to talk about questions and share with the class” (P002). Similarly, Professor 007 described the role of computers in his teaching as “quite significant, but only as a sort of mode of communication and as the way of aggregating results. I think they [students] should just be talking to each other”.

The second subgroup in student engagement category consisted of two professors whose views of effective teaching related to students’ engagement in data analysis and hands on experience on issues and methodologies related to the subject. These professors perceived a stronger role for computers in their teaching and in student learning. Professor 005 described the role computers can play in students’ learning in the following words: “when students are presenting their papers, they have to prepare their own power point presentation; so, they have to be able to get up in front of the class and present. So they learn presentation skills and how to put together a good presentation". Professor 012 considered that computers are crucial to the teaching and learning of his course:

> Computer is really crucial because it is modeling and modeling is by definition on a computer…, we can derive the equation on the board and then, you know, we can tell [computers] all you would go about solving those equations…When you develop a model, you go from simple to complex. So, at first, you only put a few ingredients…, you look at the model behaviour, and you know that this ingredient gives you this model behaviour. And you add one more ingredient and it changes the behaviour" (P012).

Professors in the learning independence/self-reliance category perceived computers as tools for learning and student development. They viewed all the facilities in the classroom including computers, the round tables, and writable walls as resources integrated in their teaching and students' learning. They expressed using the facilities for more engaging and learning-oriented ways of teaching. Some of the tools students were expected to use included databases, sheltered web quest programs, open-ended analytical tools, and systems modelling programs. Professor 013 and her students used "SPEAQ Quest"—a web quest designed for English as a second language (ESL) users. SPEAQ Quest archives information, guides, links, and tools that can be used by ESL professors and students. The professor explained that "…one of the things that the Ministry of Education wants really people to do is to learn how to use the Internet as a resource; at the same time, you can't have students to surf the Internet all over the place and going anywhere they want for obvious reasons" (P013). Thus, SPEAQ quest provided students with "sheltered search" and learning facilities that involved working on activities, looking for resources, evaluating information, using tools, and developing teaching materials.

Considering expectations and the nature of the course, the classroom "worked splendidly" as it merged tool use and collaborative learning for students (P013).

Professor 011 described computers as tools that "promote independence" when they are used by students: "Computers have their place, I don't use them for everything and I don't tell people to use them for everything" (P011). She and her students used *Concordancer*, software that is used to access and analyze language from a database (corpus) to help students develop skill of academic writing. Her reasoning was that language teaching has moved "away from teaching vocabulary in isolation" and Concordancer provides "authentic language samples" taken from newspapers, speeches, or other contexts and students "can search for the purpose of examining patterns in language" (P011). She stated: "I am not somebody who jumps on bandwagons with the latest thing. This, I think, is really judicious use of a computer tool … it really helps people to become independent".

Professor 008 expressed that computers are "central to this particular course because it is a methods course. It is actually teaching them analytical methods in dealing with sustainability issues. They are actually working on actual data and doing problem solving. So they cannot do that without computers" (008). The two reasons he forwarded for his predominant use of Microsoft Excel was— to help students develop conceptual understanding of what goes on behind the analyses/the interface and to accommodate differences in students' technical background as they had various disciplinary backgrounds. Similar to P013, this professor related the use of computer tools to ultimate learning outcomes as he expressed a hypothetical scenario where graduates might be faced with requests to solve real environmental problems such as pollution. He argued that he was training his students so that they would be able to frame the problem, manoeuvre through the available data, and provide solutions using available tools.

Professor 010, whose course mainly involved systems modelling, considered computers to be “absolute necessity” for his course because it exposed his students to “the knowledge they can gain by working with those tools in a world that they would never have had the opportunity to do that before” (P010). According to this professor, computers facilitated the teaching of his course for students who did not have a strong background in calculus and differential equations. For this purpose, he used a systems modelling software called “Stella”. Students worked on modelling exercises in the class and mostly ran into different problems which he referred to as “learning opportunities”. The network and screen access facility in the room allowed students to share and discuss encountered problems in the modelling exercise.

Professor 006 used Geographic Information System (GIS) software in his course and considered his course to be largely about using computers for analysing data and solving problems. The role he perceived for computers in his course is captured in the excerpt below.

> ...that is a very plain answer that the course wouldn’t exist without computers. So computers are the heart of it all. .. So what do computers do is not the computers support the learning exercise; they are the learning exercise (006).

Table 4 presents a holistic picture of the three conceptions of effective teaching as described by the participating professors, the expected learning outcomes, the instructional strategies professors employed, and the role professors perceived for computers in enacting their view of effective teaching.

Table 4

Professors' Conceptions of Effective Teaching and the Role of Computer Related Tools

Conception of effective teaching	Views of effective teaching	Expected outcome for students	Instructional strategies (and techniques)	Perceived roles of computer related tools
Transmitting knowledge *(3 professors)*	Making topics clear to students, giving instruction, how much students learn	Subject matter knowledge, basic skills (writing, reading), knowledge of mathematical tools and concepts	Preparing clear plans, question and answer sessions, students bringing discussion questions from reading, putting notes on WebCT, using coherent story and presenting piece by piece	Computers are tools for presenting and accessing information. Tools used include document camera, Internet, Power Point, WebCT, clickers.
Engaging students *(5 professors)*	Facilitating student interaction, creating dynamic environment, considering learners backgrounds, encouraging participation	Presentation skills, understanding debates about issues, effective team work, understanding application of theories and principles, calibrating data	Student presentation, question and answer sessions, discussions, group projects, in-class problem solving	Two views: 1) round tables preferred over computers, 2) computers are essential tools for data analysis and modelling Tools include Power point,

				ENVI, Stella
Developing learning independence/self-reliance *(5 professors)*	Students working independently, developing students' metacognitive awareness, considering learners' holistic development	Ways of approaching problems, ability to deal with technical solutions, proficiency in tool use, better sense of their own abilities, understanding work requirements	Students' independent work, group projects, summarization of articles, students developing materials and models, working on strategies and ways of learning	Computers are essential learning tools for developing independence. Tools used include Stella, web quest, concordancer, spreadsheet, GIS

Discussion

The purpose of this study was to determine how professors view effective teaching when they teach in technology rich classrooms and how their conceptions relate to the role they see for computer related tools in their teaching. In addition to professors' responses to the specific question about effective teaching, their description of expected learning outcomes for their students were also considered in drawing their conceptions of effective teaching. This approach in the analysis of the data enabled us to check the consistency of responses within a case—the alignment between views of effective teaching, expected outcomes, and related teaching strategies, thereby providing a holistic picture of effective teaching conceptions that were then examined in relation to use of computer related tools.

Three conceptions of effective teaching emerged from professors' descriptions—knowledge transmission, student engagement, and students' learning independence/self reliance. The knowledge transmission view of effective teaching was based on professors' belief that there is a structured content of the subject matter that students need to understand and the role of the teacher is making this structure easy and clear for learners. What professors expect their students to learn is defined, structured knowledge such as concepts, mathematical tools, and theories. These professors employed instructional strategies that they thought would help students to understand the content including preparing a clear plan and structure for class sessions, making clear presentations, asking questions to confirm clarity of explanations and understanding, and giving structured exercises and assignments.

The second conception, effective teaching as engaging students, took into account the importance of subject matter knowledge but also emphasized student involvement. Thus, students need to understand the subject matter not through teacher presentation but rather, through reading assigned materials, making presentations, being involved in discussions, working in groups, and other forms of interaction. Interaction with other students and with the professor as well as engagement with the material is considered an essential attribute of this view of effective teaching. Another component of student engagement had to do with getting involved in applied exercises related to methods and tools that they had learned in class. Within this context, expected outcomes extended beyond understanding the subject matter as it included developing students' skill of presentation, communication, and collaboration. Instructional strategies were predominantly interactive such as group projects, question and answer sessions, individual or group presentations, and in-class group exercises.

The third conception of effective teaching, developing students' learning independence/self reliance, focused on holistic development of learners as independent professionals and their engagement in the process. It related learning to what students already know, to defining and solving practical problems, to using relevant tools, and to working both collaboratively and independently. In this context, students assumed a more active role when they worked independently, produced artifacts (such as teaching materials and models), and interpreted results of their analyses, thereby developing their critical insight. In a way this conception of effective teaching reflects both the self-regulated and cooperative aspects of active learning (Simons, 1997) and is supported in other studies in which related terminologies such as "life-long learning" (Akerlind, 2004;

Saroyan et al., 2009) are used. What professors expect their students to develop include strategies, ways of approaching new and different problems, better sense of their own abilities, and the ability to work with available tools. Students work on projects where they define the boundaries of problems and work on solutions, develop materials, summarize articles, and make presentations. The professors have largely a supportive role in the process.

The extent to which these categories are the same as or different from conceptions generated in previous studies by other researchers and whether or not these categories of conceptions are indeed context specific are worth discussing. The three hierarchical representations of effective teaching reported in this study are in part similar to previous findings (Kember, 1997; Kember & Kwan, 2000; Ramsden, 2003; Trigwell & Prosser, 1996b). For example, Kember (1997) in his review of 13 primary studies on conceptions of university teaching identified two main orientations—teacher-centered/content-oriented and student-centered/learning-oriented, connected with a transitory category, student-teacher interaction. According to Kember's (1997) conceptual framework, the student-centered/learning-oriented orientation is characterized by facilitating student learning and changing their conceptions. The findings and categories of the present study differ from categories generated by previous studies, especially Kember's (1997) framework, in two ways. First, in the third category—learning independence/self-reliance, none of our five professors mentioned anything about students' changing conceptions. Rather, they focused on students' development as professionals and their ability to meet task related demands such as ways of thinking and approaching problems, producing materials (e.g., teaching materials and models), and developing learning strategies and metacognitive awareness. One reason can be that Kember (1997) drew his "conceptual change" category mainly from studies by Prosser, Trigwell, and Taylor (1994) and Trigwell et al. (1994) where only first year physical science teachers comprised the sample and the issue of changing misconceptions and preconceived ideas were emphasized in their views of teaching. Second, looking at the descriptions of effective teaching, expected outcomes, and learning strategies, the student engagement category in our study reflects relatively more student agency in the teaching learning process compared to Kember's (1997) transitory category of "teacher-student interaction". Learners' activities and responsibilities are clearer. Samuelowicz (1999) was critical of the transitory category, "teacher-student interaction", suggested by Kember and other researchers stating that it is "the nature of the interaction which is important not the interaction as such because depending on the nature of the interaction, teaching could be seen as either transmitting information or facilitating learning (p. 11).

As described above, there are differences between professors' conceptions of (effective) teaching reported in previous studies and the ones reported in this study. However, given the data we have, it is difficult to conclude that these differences are completely due to the technology-rich classrooms or the conceptions are completely context-specific, context being technology rich classrooms. If it were for technology rich classrooms, all the participating professors would have similar conceptions as they were teaching in the same classroom. It could, rather, be due to a combination of factors including the nature of the course, the classrooms, and professors' views of teaching and student learning (Entwistle et al., 2000).

Our findings also revealed that there is clear alignment between descriptions of effective teaching, expected learning outcomes, and reported instructional strategies in all the three categories of conceptions. Also, as described below, professors' reported use of computers in their teaching and/or the way they expect students to use computers in their course appeared to be in line with their conceptions. This alignment supports the idea that conceptions of teaching influence instructional approaches and strategies (Carnell, 2007; Entwistle et al., 2000; Trigwell & Prosser, 1996b). It is a new finding that professors with different conceptions of effective teaching see the role of computers in their teaching differently.

Maddux and Johnson (2005) identified two types of use of computers in schools which they called “Type I” and “Type II” applications. Type I applications are use of computer related tools in a way that makes it “faster, easier, or otherwise more convenient to continue teaching or learning in traditional ways” (p. 3). Type II applications use the tools to teach and learn in new and better ways that facilitate student learning and development. These two types of use are manifested in our findings. Professors with knowledge transmission view of effective teaching considered computers to be presentation tools and it was primarily for this purpose that they used them. They used the document camera, power point, clickers, and the Internet in their teaching mainly to access and present information; and ultimately to make teaching easier.

On the other hand, professors who viewed effective teaching as developing students’ learning independence/self reliance perceived computers as essential tools for student learning. These professors used and made their students use databases, modelling software (e.g., Stella), spreadsheets and web quest, among others. These types of applications are open-ended tools that students can learn with, think through, and express their knowledge with, rather than confine their thinking process (Jonassen & Reeves, 1996). They are open-ended in the sense that students can choose how and when to use them. In the case of the spreadsheet and modelling software, for example, students had to define variables, test their hypothesis, and check alternative solutions. When students use such tools they engage actively in the learning process. It was not only the type of applications or software that these professors and their students used that was different; it was also their instructional strategies and expected learning outcomes that were different.

For professors who viewed effective teaching as engaging students, the role of computers was related to how they operationalized student engagement. Those who emphasised social aspects of engagement such as group discussion, collaboration, and communication saw a limited role for computers; those who considered student engagement as being involved in hands-on exercises and modelling see greater role for computers as data analysis and modelling tools.

The importance of professors' conceptions in their teaching practices has been empirically supported in the past (e.g., Trigwell & Prosser, 1996b). What is new in this study is the addition of the technology dimension to the equation. Findings point to a relationship between one's view of effective teaching and the use of technology in teaching. The study has implication for faculty development programs related to technology appropriation. The successful implementation of technology in university teaching will depend on conceptions of faculty about effective teaching and these conceptions can be influenced through faculty development programs (see for example Ho, Watkins, & Kelly, 2001). Whether technology helps professors in changing their conception of effective teaching or a change of conception is a prerequisite for using computer related tools in a way that makes meaningful contribution to student learning is an issue for further discussion and research. In any case, conceptions of teaching and related instructional strategies remain to be integral parts of technology related faculty development programs.

Related future research should focus on determining different aspects of student engagement in classes of professors with different conceptions of effective teaching and technology use. Given the technology rich nature of this research context, such research, in addition to determining aspects of student engagement, can help in assessing technology rich or active learning classrooms.

Bridging Manuscript

Student engagement in worthwhile educational activities is considered to be necessary condition for student learning. Engagement is a "metaconstruct", an organizing framework that has behavioral, psychological, cognitive, and motivational components (Christenson, Reschly, & Wylie, 2012; National Research Council and the Institute of Medicine, 2004). In higher education context and in the context of this dissertation research, student engagement refers to the nature and extent of students' perceived and/or actual "involvement" in academic activities that contribute to their learning and academic progress. This definition is in line with Astin's (1984) conceptualization of the construct. Astin (1984) noted that involvement refers to exerting physical and psychological energy and occurs along a continuum reflecting the extent to which rather than whether or not students are involved in their academic activities.

Engagement is not a personal attribute; rather it is a state of being that can be changed and influenced by contextual factors (Astin, 1984; Christenson et al., 2012). Accordingly, researchers and institutions aspire to determine factors that determine student engagement and disengagement (Nelson Laird & Kuh, 2005; NSSE, 2008 Report; Pike & Kuh, 2005; Sandholtz, Ringstaff, & Dwyer, 1994). In the university context, investigating student engagement and determining variables has so far focused at the institution level rather than classroom or course level experiences. More importantly, despite increasing evidence that the value added aspect of computers in student learning is related to students' active and mindful engagement in the learning process and in using the tools rather than to the presence of the tools, *per se* (e.g., Schmid et al., 2009), what students do using the computers and the nature of their engagement in technology rich classrooms has not been examined.

Considering the increasing focus in higher education institution on student engagement (Shulman, 2002) and on designing learning environments that facilitate learners' experience, it is timely to investigate the issue in relation to effective teaching. The idea is that effective teaching should explicitly consider and plan for active involvement of students in the course and classroom context and the use of computer related resources available in the classroom to foster greater engagement.

The study in Manuscript 3 has the main purpose of determining the nature and extent of student engagement in technology rich classrooms and examining its relationship to conceptions of effective teaching. The findings of Manuscript 2 established that professors' conceptions of effective teaching are related to their perceived use of computers in their teaching. Manuscript 3 extends this finding by considering the students' perspective—capturing their perceived engagement and relating it to their professors' conceptions of effective teaching. This study used a quantitative approach to determine the nature and extent of student engagement. An instrument was developed for this purpose, taking into account features of active learning environments identified in the first manuscript as well as components of "pedagogical design" (Lakkala et al., 2008) and rich learning environments (Grabinger, 1996).

Chapter IV: Manuscript 3

Students' Engagement in Technology Rich Classrooms and Its Relationship to Professors' Conceptions of Effective Teaching

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Abstract

This study examined dimensions of student engagement in technology rich classrooms and the relationship of this engagement to professors' conceptions of effective teaching. We collected questionnaire data from 332 students and analysed the data in relation to the finding of another study (Gebre, Saroyan, & Aulls, forthcoming) involving 13 professors' course-specific conceptions of effective teaching. Principal component analysis with varimax rotation revealed four dimensions of student engagement: cognitive and applied engagement, social engagement, reflective engagement, and goal clarity. Subsequent multivariate and univariate analyses of variance showed that the extent of students' cognitive and applied engagement and social engagement is related significantly to professors' conceptions of effective teaching. The study has implications for the design and assessment of technology rich learning environments and for faculty development programs involving technology use in their teaching.

Key words: *Active learning classrooms, technology rich learning environments, Student engagement, effective university teaching*

Introduction

The value added role of computer technologies is attributed to the way they are used in the teaching and learning processes rather than to their mere presence in the classroom or the special features associated with the technologies (Bain et al., 1998; Jonassen, 2000; Kim & Reeves, 2007). Given this perspective, a logical deduction would be that the role of computers for student learning ought to be understood within the context in which it is appropriated (Bain et al., 1998; Salomon & Almog, 1998). Salomon and Perkins (1998) have argued compellingly that cognitive and social aspects of learning are intertwined and have further asserted that any research on learning and technology should use a composite unit of analysis that involves the cognitive activity, the learning goal, the social context, and the learning medium and materials.

If one agrees that learning environments influence the extent of student engagement (Bransford et al., 2000) and that the design of these environments, in turn, is influenced by teachers' views and orientations about effective teaching (Kember & Kwan, 2000; Pajares, 1992), then one would assume that a full understanding of computer use in classroom contexts will require examining the learning environment including the nature and extent of student engagement, the rationale for the use of computers, as well as views on effective teaching. There is considerable literature on student engagement; however, it has not been studied in relation to teachers' conceptions of effective teaching especially in the context of technology use. This study was conducted to address this gap and had two purposes: a) to determine the dimensions of students' engagement in technology rich classrooms, and b) to delineate the relationship between student engagement and professors' conceptions of effective teaching.

Student Engagement

In the context of postsecondary education, the nature and extent of student engagement is considered to be an important factor for student learning and personal development (Hu & Kuh, 2002; Kuh, 2001; Sun & Rueda, 2012). Student engagement is also considered to be a major indicator of the quality of postsecondary education (Kuh, 2001; Lutz & Culver, 2010). Engagement may refer to both academic and non academic aspects of college and university experience and may involve activities such as participation in sports and other social or extracurricular activities. In this paper, we have limited the scope of engagement to only academic aspects and have adopted Hu and Kuh's (2002) definition of student engagement as "the quality of effort students themselves devote to educationally purposeful activities that contribute directly to desired outcomes" (p. 555). Considering "quality" as fitness for purpose, the quality of effort is determined by the extent of students active and deliberate involvement in course related activities and in activities that "promote higher-quality learning" (Krause & Coates, 2008).

Student engagement has been the subject of research for more than two decades (Chickering & Gamson, 1987; Sherman, Armistead, Fowler, Barksdale, & Reif, 1987). The thrust of this research has been to identify factors that lead to student engagement and disengagement in postsecondary education. This research has yielded various indicators of student engagement (NSSE, 2008 Report; Sheard et al., 2010). Commonly used indicators especially in US and Canada are the five benchmarks of effective educational practice identified by the National Survey of Student Engagement (NSSE). These benchmarks include the level of academic challenge, active and collaborative learning, student-faculty interaction, enriching educational experience, and supportive campus environment. From a broader perspective and in a way that takes into account the increasingly changing lifestyle of students, Sheard et al. (2010) have elaborated that meaningful student engagement will necessitate behavioural, cognitive, and affective engagement. In addition to these indicators, publications such as Chickering and Gamson's (1987) seven principles of good practice in undergraduate education which include student-faculty contact, cooperation among students, active learning, prompt feedback, emphasis on time on task, communication of high expectations, and respect for diverse talent and ways of learning have been instrumental in focussing activities of students, faculty, and administrators to tasks that can foster student engagement and produce desired learning outcomes (Kuh, 2001).

NSSE benchmarks provide a set of good indicators of student engagement and quality of learning experience (Kuh, 2003; Pike & Kuh, 2005). Using these benchmarks, Carini et al. (2006) reported modest but statistically significant positive correlation between aspects of student engagement and desired learning outcomes as measured by GPA and critical thinking scores. Notwithstanding this finding, the NSSE survey has a limited scope as it is an annual information source about undergraduate experience of students enrolled in institutions that participate in the survey. While it can serve as a basis for decision making by administrators, prospective students, and parents (NSSE, 2008 Report), it does not have the additional purpose of providing evidence or insight into classroom based engagement. For example, in the survey, students are not asked about the nature and level of engagement they experience in a specific course or classroom context and NSSE data do not provide the kind of information that instructors and instructional designers can use to design instruction that engages students in active learning while taking full advantage of available facilities. Information at this level is especially useful in contexts where classrooms are equipped with computers and related technologies and instructors have the added challenge and responsibility to use them effectively and innovatively. There is a paucity of research in this area.

A meta-analytic study by Schmid et al. (2009) involving 231 primary studies in higher education revealed interesting findings about the use of computers in teaching and learning and its relationship to student academic performance. One of the findings of this study was that when computers are used as cognitive tools, student performance scores are significantly higher compared to when these technologies are used as presentation tools. Another finding was that high technology saturation (such as using many different types of applications or using the tools for a long time) results in significantly low performance scores compared to low and medium technology saturation. A logical conclusion, then, is that the nature of engagement or what students actually do with the tools to assist them in their learning is a determining factor of the level of significance attributed to computers as a learning tool.

The student engagement research, for the most part, is underpinned by a constructivist view of education in which learning is considered to be the learner's active construction of knowledge through authentic and collaborative engagement in generative learning experiences (Chickering & Gamson, 1987; Krause & Coates, 2008; Lutz & Culver, 2010; Zhao & Kuh, 2004). Moreover, learning with technology research suggests that computer related tools can successfully facilitate constructivist oriented teaching and student learning (Jonassen, 2000, 2003; Kim & Reeves, 2007). However, the mere presence of the tool does not guarantee constructivist learning and instruction. As asserted by different researchers, the way the learning activity is designed and what students actually do in the learning process plays a significant role in how students appropriate the tools (Jonassen, 2000; Schmid et al., 2009). Learning environments that are more student rather than teacher-centered, coupled with appropriate motivation and support, are more likely to provide students with the autonomy and independence needed to engage in more self-regulated learning activities, thereby developing their self reliance.

Effective University Teaching Conceptions

Teachers' conceptions of teaching—representations of how teachers view and characterize teaching (Cole, 1990) — influence their teaching approaches and strategies (Kember & Kwan, 2000; Pajares, 1992; Pratt, 1992; Saroyan et al., 2009; Trigwell & Prosser, 1996b). They can also influence the way learning environments are designed and technologies are appropriated for academic purposes (Cuban, 1993). Indeed, it may be that conceptions of teaching and teachers' agency to change classroom practices are more fundamental than institutional barriers in determining the success of technology appropriation in teaching and learning (Ertmer, 1999). It is worth noting here that we acknowledge the inconsistency and ongoing discussion about the use of different terms including "conceptions", "beliefs", "teacher knowledge", and "perceptions" to describe the same thing (Kane et al., 2002; Saroyan et al., 2009). We use "conceptions" because they carry "personal meanings" that can be activated and changed in relation to specific contexts (Entwistle et al., 2000). Conceptions are "relational" descriptions or conceptualizations rather than generalizations fixed in memory (Trigwell et al., 1994) that "underlie the purpose and strategies of teaching" (Postareff & Lindblom-Ylänne, 2008). These relational descriptions may vary based on the context of teaching such as level of students (Samuelowicz & Bain, 1992) or the nature of the course. Conceptions of teaching also reflect the pedagogical awareness of professors (Löfström & Nevgi, 2008) which influences the way in which they design learning environments including those that involve technologies.

Similar to the student engagement research, research on teaching conceptions is guided by constructivist views of teaching and learning. Most studies in this body of literature represent university teachers' conceptions with respect to the extent of their student-centeredness (e.g., Kember, 1997; Kember & Kwan, 2000; Samuelowicz & Bain, 1992, 2001). Features of student-centered teaching include providing opportunities for students to become autonomous thinkers, to manage their learning activities, and to have experience of addressing challenging issues (Perkins, 1992). This view of teaching necessitates a shift in teaching strategies, classroom culture, and the role of teachers and students with emphasis placed on students' adoption of learning strategies and their overall development (Chang, 2005).

Student-centered teaching is anchored in a number of factors: a) understanding how students learn, b) utilizing context-based pedagogical approaches, c) determining the capabilities and limitations of available technological resources, and d) considering practicality of the various combinations of tools and strategies to result in promoting intended learning outcomes (Hannafin et al., 1997). Research on conceptions of academics suggests that professors' use of student centered approaches in their teaching is related to both the way they conceive teaching as well as what they intend to achieve through their teaching (Trigwell & Prosser, 1996b). In their study of the relationship between teaching intentions and strategies, Trigwell and Prosser (1996b) reported that science professors with information transmission view of teaching tend to follow more teacher-focused strategies; those who view teaching as changing students' conceptions follow more student centered strategies. Saroyan et al. (2009), in their study of the goals of teaching and related student learning, reported that the agency of the professor is dominant when the goal of teaching is transmitting information; however, the focus shifts from the teacher to student learning when the goal of teaching becomes promoting lifelong learning for students.

Gebre, Saroyan, and Aulls (forthcoming) studied 13 university professors who were teaching in technology rich classrooms. They looked at professors' conceptions of effective teaching and the relationship of these conceptions to their use of computers in teaching of a specific course. Semi-structured interviews were used to elicit professors' conceptions of effective teaching, their expected learning outcomes, their chosen instructional strategies, and the role they saw for computers in their teaching. Drawing from the provided descriptions, the study identified three conceptions of effective teaching— transmitting knowledge, engaging students, and developing independent learning/self reliance.

Professors with knowledge transmission view of effective teaching considered computers as tools that make their teaching more convenient and easier. They often used document camera, Microsoft Power Point, Internet, and WebCT—Type I applications of technologies (Maddux & Johnson, 2005). Three of the five professors in the student engagement category expressed their preference for round tables in the room over computers mainly because the physical set up facilitated discussion and interaction. The other two professors considered computers as important components of their course because they and their students used them for data analysis and modelling purposes. Students in classes of these professors used computers to make presentations, access information, and work on data analysis.

The third group of professors, those who viewed effective teaching as developing students' learning independence, perceived computer related tools as essential components of the course and student learning. Their students used databases, web quest, spreadsheets, and modelling applications such as Stella—Type II use of technologies in teaching and learning (Maddux & Johnson, 2005) or used computers as cognitive tools (Jonassen, 2003; Jonassen & Reeves, 1996).

The purpose of the present paper was to extend the findings of the second manuscript and to relate professors' conceptions of effective teaching to student engagement in technology rich classrooms. More specifically, the present study had two purposes: a) determining dimensions of student engagement in technology rich classrooms; and b) examining the relationship between dimensions of student engagement and professors' conceptions of effective teaching.

Methods

Context and Participants

The research site was a large research-intensive university in Eastern Canada. In 2009, the University established the first two active learning classrooms. Active learning classrooms (ALC) are examples of rich environments for active learning (REAL) (Grabinger, 1996), often established with the purpose of integrating technology, facilitating better student learning, and improving teaching practices (Pundak & Rozner, 2008). Rich learning environments are comprehensive systems of learning and instruction that involve active as well as collaborative engagement of students in authentic and generative learning activities with the goal of integrating or constructing knowledge and achieving higher level thinking and problem solving capabilities (Grabinger, 1996; Kovalchick & Dawson, 2004). Although Grabinger (1996) contends that rich environments for active learning do not necessarily require computer related technologies, computers can be powerful tools that can facilitate active learning and constructivist oriented teaching (Dori & Belcher, 2005; Jonassen, 2000, 2003; Kim & Reeves, 2007).

Various universities in North America have introduced active learning classrooms as learning enhancement projects such as the Technology Enabled Active Learning (TEAL) at MIT, the Student-Centered Active Learning Environment for Undergraduate Programs (Scale-UP) at North Carolina State University, and the Active Learning Classroom (ALC) project at University of Minnesota (Dori & Belcher, 2005), to mention some.

The two active learning classrooms in the University where this study took place were set up to encourage interaction between students and faculty, promote active and collaborative learning, enrich educational experiences, and provide a pedagogically supportive environment. One of the rooms (Room 1) has the capacity to accommodate 72 students at eight large round tables – each with nine seats, two computers with screen sharing facilities, a microphone, and connection slots for laptops. The professor's podium is located in the center of the room with facilities for accessing each computer screen in the room and displaying it for class discussion when necessary.

The second room (Room 2) has a capacity of 38 students accommodated at six long tables with a one-to-one student-computer ratio. The professor's podium is at the corner of the room, and like Room 1, has PC with screen access/sharing facilities. Both rooms have writable walls, converted from their traditional design to accommodate the technological infrastructure.

Student Survey Instrument

As a rule, student engagement research is underpinned by a constructivist view of education in which context is considered to be an essential component of teaching and learning and the role of computer related tools can be understood better when it is studied in reference to the whole context in which it is applied (Bain et al., 1998). The instrument, *Student Engagement in Technology Rich Classrooms (SETRC) survey*, was developed based on recommendations in the conceptual literature that students' cognitive engagement and social interaction as well as the learning goal and learning materials need to be studied together (Salomon & Perkins, 1998). The instrument was initially developed as a 28-item, 5-point Likert-scale survey—the scales being "Never", "Seldom", "Sometimes", "Often", and "Always". Survey items, accordingly, related to what students actually do with computers in the course (Jonassen, 2003; Jonassen & Reeves, 1996), their collaboration and communication with other students (Bain et al., 1998), and their awareness of what they are learning. The items reflect the context-oriented perspective on computer use and as such, respondents are asked to answer questions within the context of the course they are taking in the active learning classroom with the particular professor. Accordingly, the following criteria were considered in the development of the instrument.

a. *Constructivist perspective and student-centeredness*. Items should reflect student-centered nature of learning and focus more on what students do in the process.
b. *Cognitive and social aspects of engagement*. Items should emphasize students' academic engagement and address both individual and social aspects of learning.
c. *Technology orientation*. Items should reflect what students do with computers and the technology-oriented nature of the learning context (Jonassen, 2003; Jonassen & Reeves, 1996).
d. *Extent of engagement.* Alternative responses should have a continuous rather than categorical nature and reflect extent of engagement rather than whether or not students are engaged in the activity identified by a given item (Astin, 1984).
e. *Economy*. Items should be easy to answer. The scales should be reliable with limited number of items on a scale (Fraser, Treagust, & Dennis, 1986).

The draft questionnaire was pilot tested with two professors and one PhD student and feedback related to its content validity and ease of use were used to develop the final version.

Participants for the study were 13 professors and 232 students. The professors had a rank of at least assistant professor, with the exception of two faculty lecturers[2], and were from an array of disciplines including philosophy, physics, law, English as second language, geography, continuing education, and electrical and computer engineering—

[2] *A faculty lecturer is a non-tenure track position.*

constituting 68% of the professors who were scheduled to teach in the two active learning classrooms in winter 2011. Two of the 13 professors opted out of the active learning classrooms after class started for the term, but we maintained their participation in the study.

Following interviews conducted with professors, students of the 11 professors who continued teaching in the active learning classrooms were recruited by the first author. The process involved visiting the classes in person, describing the purpose of the study, and extending an invitation to participate in the study. Sixty five percent of students who were attending classes of the 11 professors consented to participate and completed the paper copy of the instrument. No compensation was offered for participating in the study and they were informed that non-participation would have no consequence whatsoever. There were 115 female and 112 male students (five students did not identify their gender), with 65% undergraduate and 35% graduate enrolment.

Data Analysis

SPSS version 17 was used to analyze the data. In the survey missing values accounted for less than 3% and were replaced with series mean. Four surveys were discarded due to less than 50% completion, resulting in 228 complete surveys after the imputation. One purpose of the study was to determine dimensions of student engagement while using computers for learning in technology rich classrooms. To address this objective, we performed a principal component analysis (PCA) with varimax rotation to identify clusters of items and determine the smallest number of underlying factors that could be used to describe student engagement in computer-based classrooms.

Once the components were obtained, we calculated component scores for each student. This score is the average of variables with substantial loading on the component and estimates the score "students would have received on each of the components had they been measured directly" (Tabachnick & Fidell, 2007, p. 650; Zwick & Velicer, 1986). This allowed us to compare the extent of student engagement across the three conceptions of effective university teaching presented in Table 1. Subsequently, we performed multivariate analysis of variance considering the components of student engagement as dependent variables and professors' conceptions as the independent variable. Use of principal component analysis and multivariate analysis of variance together in answering research questions is well supported in the literature because PCA reduces large number of dependent variables to smaller number of components that can be used as a dependent variable in MANOVA (Tabachnick & Fidell, 2007). There were a total of 44 students in classrooms of professors with transmitting knowledge view of effective teaching, 84 in classrooms of professors with student engagement view of effective teaching, and 100 in classrooms of professors with developing learning independence/self reliance view of effective teaching.

Results

Components of Student Engagement

Initial extraction produced eight components accounting for 61.6% of the variance. Based on the suggestion of Zwick and Velicer (1986) regarding the number of item loadings on a major component, two components with loadings of only two variables each and a third component with only one item loading were excluded. This process resulted in eliminating five items. In addition, four items were excluded because of cross-loading and analysis of item-total statistics. A rerun of the analysis with the remaining 19 items produced four components accounting for 55% of the variance. One item (item 19) cross-loaded on components 3 and 4, which was not the case in the first extraction. Because component 4 had only three loadings including item 19, dropping this item would have led to dropping the fourth component itself; thus, we maintained the variable despite the cross loading. Other than this cross-loading, the component structure appeared clearly with moderate to strong loadings of variables on the four components. The components were also supported by the scree plot which yielded four clear components. Bartletts' test of sphericity for the 19-item instrument was 1482 ($p < .001$) and Kaiser-Meyer-Olkin measure of sampling adequacy was .85 indicating the reliability of the principal component analysis and the compactness of the correlations to produce distinct components. See Table 5.

Table 5

Factor Loadings for Principal Component Analysis with Varimax Rotation of Students' Engagement in Technology Rich Classrooms

	Components of Engagement			
Item	Cognitive and Applied (1)	Social (2)	Reflective (3)	Goal Clarity (4)
1. Classroom use of computer supports my efforts to achieve the goals (of learning this course)	.782			
2. I engage in representing my understanding of concepts using computers	.781			
3. I engage in analysing information, comparing and contrasting ideas using computers	.760			
4. Classroom activities involve individual problem solving occasions using computers	.744			
5. The learning activities have practical dimension (involve learning by doing)	.601			
6. I can easily see the possible application of what I learned in this course to work place settings	.590			
7. Classroom activities and discussions in general are related to real world situations	.564			

8. I interact with other students in the course using emails and WebCT	.807		
9. I engage in online, out of class discussion related to the course with my classmates	.695		
10. I communicate with the professor using emails and WebCT	.606		
11. I cooperate with other students while working on assignments	.570		
12. Students use multiple sources of information (Internet, references, etc.)	.520		
13. I engage in discussion with other students on the same table	.509		
14. The classroom allowed me to think loud (expression of ideas, procedures, algorithms, answers, etc. in the classroom)		.712	
15. I engage in reflecting on my learning		.652	
16. I engage in meaning making and constructing knowledge about the course		.626	
17. I am aware of the purpose(s) of each classroom session			.802
18. The learning goal is clearly communicated in each session			.714
19. Course materials are related to learning goals		.403	.476

Note: Component loadings are >.40

Components were clearly interpretable considering the respective loading of the variables. The first component, which accounted for 20.1% of the variance, has items related to two types of student engagement. The first is cognitive or intellectual where students represent their knowledge, solve problems, and work on analysis and interpretation of data using computers. The second is practical or applied knowledge or engagement. We named this component, which has seven items, "cognitive and applied engagement". The second component that accounted for 14.1% of the variance has six items related to interaction with peers and the professor as well as collaboration with students around the same table and/or in the same course. We named this component "social engagement". This does not, however, imply participation in non-academic social gatherings such as athletic and other activities. The third component accounted for 10.7% of the variance and has four variables (including the cross-loaded item) related to reflection about ones learning. We named this factor "reflective engagement". The last component was named "goal clarity" and it accounts 10% of the variance with three variables loading on it. The variables relate to clearly understanding the learning goals and the relevance of learning materials.

To establish the reliability and the internal consistency, we also calculated Cronbach's alpha coefficients which yielded .86, .73, .67 and .65 for the four components, respectively; and .87 for the 19-item instrument in general.

Students' Engagement and Professors' Conceptions of Effective Teaching

Once the factors were obtained and composite scores were computed, we used multivariate analysis of variance (MANOVA) to examine any association between professors' conceptions of effective teaching and the components of student engagement, using conceptions as the independent variable and the four latent variables as dependent variables.

Table 6

Mean and Standard Deviation of Student Engagement Scores

Professors' Conception	No. of students	CAE	SE	RE	GC
Transmitting knowledge	44	2.71	2.87	3.67	3.90
		(0.69)	*(0.62)*	*(0.58)*	*(0.74)*
Engaging students	84	3.74	3.59	3.90	4.03
		(0.65)	*(0.68)*	*(0.63)*	*(0.61)*
Developing independence/ self reliance	100	4.08	3.48	3.88	4.07
		(0.55)	*(0.72)*	*(0.59)*	*(0.62)*
Total	**228**	**3.69**	**3.40**	**3.85**	**4.02**
		(0.79)	*(0.73)*	*(0.61)*	*(0.64)*

CE=cognitive and applied engagement; SE=social engagement; RE=reflective engagement; GC=goal clarity

The multivariate results were significant, Wilks's Λ=.50, F(8, 444)=23.41, p <. *001;* indicating an overall effect of professors' conceptions of effective teaching on the extent of student engagement. Subsequent analysis of variance showed that there was a significant difference between the three groups in cognitive and applied engagement, $F(2, 225) = 76.12$, $p < .001$; and in social engagement, $F(2, 225) = 17.05$, $p < .001$. However, there was no significant difference among the categories in students' reflective engagement, $F(2, 225) = 2.36$, $p > .05$ and goal clarity, $F(2, 225) = 1.06$, $p > .05$.

The Tukey post hoc comparisons of the three groups indicated that there was a significant difference in students' cognitive and applied engagement between the three categories of conceptions. The mean score for this component was highest in developing learning independence/self reliance category (M=4.08, SD=0.55); followed by the student engagement category (M=3.74, SD=0.65); and the least in transmitting knowledge category (M=2.71, SD=0.69)—all with $p < .001$.

Concerning social engagement, post hoc comparisons showed that students in transmitting knowledge category reported significantly low scores (M=2.87, SD=.62) when compared to students both in student engagement category (M=3.59, SD=.68) and in learning independence/self reliance category (M=3.48, SD=.72), $p < .001$. However, the difference between mean scores of students in student engagement category and learning independence/self reliance category was not significant, $p > .05$.

Discussion

This study aimed at 1) determining dimensions of student engagement while taking courses in technology rich classrooms, and 2) examining the relation between the extent of student engagement and professors' conceptions of effective teaching for the course they were teaching in technology rich classrooms. The four latent variables that emerged from the student survey represent dimensions of student engagement. These dimensions are in line with what literature suggests—that students need to be mindfully engaged in intellectual activities when using computers, collaborate and work with other students using the tools, reflect on their learning and develop their metacognitive awareness, and be clear about the learning experience (Bain et al., 1998; Jonassen & Carr, 2000; Richardson & Newby, 2006; Salomon & Almog, 1998; Shields, 1995). In support of students' cognitive engagement using computer related technologies, Jonassen and Carr (2000) have argued that learners' engagement in articulating what they learn and know and representing their understanding in a way that is accessible to others leads to better cognition. This is because students deal with learning tasks that require mental efforts or complex cognitive activities (Corno & Mandinach, 1983; Stoney & Oliver, 1999).

Examination of items that loaded on social engagement revealed two themes—working in groups including in-class discussion and communicating. This finding highlights the social context of learning and its importance for appropriating the technology meaningfully (Salomon & Perkins, 1998). This role of social engagement and interaction for student learning has been well documented in the literature (e.g., Bernard et al., 2009). Although the focus of their study was distance education, Bernard et al. (2009), in their meta analytic study, reported that the strength of student-student interaction was significantly related to student achievement with high interaction resulting in better results compared to moderate or low interaction.

Reflection has to do with being aware about what one is doing (McAlpine & Weston, 2000) and is part of metacognitive awareness (Salomon & Globerson, 1987). Thus, students' reflective engagement about their learning and the use of technology constitutes an important aspect for effective learning and developing learning independence. Goal clarity implies students' awareness of the goals of the session and the relevance of the learning materials to the stated goals. It should be noted that, though acceptable (DeVellis, 1991), the reliability of the last two factors was relatively low which can be partly explained by the small number of items forming these dimensions.

The MANOVA and ANOVA results showed that students' cognitive and social engagement in technology rich classrooms is significantly related to their professors' views of effective teaching. Higher cognitive and applied engagement was reported in classrooms of professors with conceptions of effective teaching as developing students' learning independence/self reliance. On the other hand, students of professors who viewed effective teaching as transmitting knowledge reported the lowest level of engagement both in cognitive and social dimensions. Given the influence of views and conceptions on teaching approaches and strategies (Kember & Kwan, 2000; Trigwell et al., 1994), this finding supports the argument that the design of learning environments and the manner of appropriation is an important factor for effective use of computers for student learning (Pea, 1993; Schmid et al., 2009). The design of learning environments has a role of bridging the affordances of the tools and relevance of learning activities but it, in turn, is influenced by what professors consider effective teaching in their course. As indicated in the results section, the three groups of students did not significantly differ in terms of the last two components of student engagement—goal clarity and reflective engagement. This might be attributed to the fact that irrespective of their conceptions of effective teaching, professors make the purpose of a session clear to students when they start teaching and relate the current topic to what has been covered before or to the overall goal of the course. At the same time, they may encourage their students to reflect on what they have learned or to make connections between previously learned materials and current sessions. Alternatively, this absence of significant differences may simply reflect an instrumentation problem, because these latter two components were the lowest in accounting for variance in the student ratings.

The study makes two major contributions. The first contribution comes from the emergence of the four components from the survey that determine aspects of students' active engagement in technology rich classrooms. This can be useful in designing learning environments involving technologies and in the assessment of their effectiveness. Understanding students' engagement in technology rich environments also provides useful information about their broader educational practices; as Nelson Laird and Kuh (2005) have reported, there is a strong relationship between students' engagement with information technology in relation to their learning and their involvement in effective educational practices including active and collaborative learning and better student-faculty interactions. Given that the four components identified in this study relate to student engagement at the classroom and/or course level as opposed to general experience of postsecondary education, it can provide meaningful information to instructors and instructional designers about designing learning environments.

The second contribution relates to professional development of faculty. Technology implementation in university teaching needs to incorporate faculty development programs related to changing professors' conceptions of effective teaching. Whether technology helps to change conceptions of teaching or whether technology use is a result of a change in conceptions are issues that need further research. Studies such as the one conducted by Ho et al. (2001) suggest that conceptual change attained following faculty development initiatives can result in the innovative use of technologies in teaching. Gebre, et al. (forthcoming) have also reported a relationship between professors' conceptions about their teaching with their use of computer related technologies in teaching. Using pedagogical training data on 200 professors, Postareff, Lindblom-Ylänne, and Nevgi (2007) have reported a significant positive effect of pedagogical training on developing professors' conceptual change/student-centered approaches to teaching. These findings suggest that faculty development programs concerning technology integration need to go beyond developing professors' technological competence and holistically address their conceptual, pedagogical, and technological dilemmas (Mishra & Koehler, 2006; Windschitl, 2002). When professors have more "sophisticated" conceptions of teaching, it is more likely that they use instructional strategies that result in student learning and active engagement in the process (Carnell, 2007; Trigwell & Prosser, 1996a).

The most immediate follow-up to the present study, in our opinion, is the validation of the instrument used herein. This would include adding more items especially to the last two factors, reflective engagement and goal clarity. Considering the self-reported nature of student engagement data it is also useful to examine how students' engagement in the identified four dimensions relate to measures of actual learning performance.

Chapter V: Conclusion

Summary of Finding

Using computers and related tools for student learning requires considering the whole teaching and learning context and designing appropriate learning activities. Such consideration of context and design of learning activities needs to balance the affordance of the tools with the agency of the learner. Given the increasing emphasis institutions place on students' active engagement in the learning process and establishment of physical facilities and resources for the purpose, it is imperative to examine whether or not professors view their teaching in terms of engaging students actively in the teaching and learning process. The main purpose of this dissertation research was to 1) understand how professors conceptualize effective teaching when they teach in active learning classrooms, 2) determine aspects of student engagement in technology rich classrooms, and 3) investigate the relationship between professors' conceptions and student engagement in technology rich classrooms. This was done in three parts.

The first part of the dissertation, based on critical review of literature, established a perspective (Pratt, Arseneau, & Collins, 2001) of effective teaching as designing of learning environments. First it examined the literature on the use of computers as cognitive tools. While there are conceptual and empirical support for the use of computer related technology as cognitive tools, there are also questions related to a) the focus of this body of literature on learning *per se* and the lack of reference to teaching and the role of the professor as designer of the learning environments, b) the lack of clarity as to what constitutes a cognitive tool; that is, it is not clear as to whether the features of the tool or the way the tool is appropriated makes a computer a cognitive tool, c) the focus of cognitive tool research on individual learning and minimal consideration given to the social and collaborative aspects, specifically, in natural settings.

After providing theoretical support for the use of computers as cognitive and learning tools, this section synthesized characteristics of computer-based cognitive tools that can be used in classroom or natural settings. These characteristics include strategies for cognitive processing of information to provide learners the opportunities for active and mindful engagement, open-endedness of the tools to allow learner control and responsibilities, and the situated and collaborative nature of the learning activities.

The next section of the first manuscript reviewed conceptions of effective university teaching from two sources of studies—studies on exemplary professors and studies on conceptions of (effective) teaching. Studies on exemplary professors aim at delineating skills, attributes, and practices of award-winning or expert professors. Descriptions of effective teaching in this set of studies relate to depth of subject matter knowledge and what professors do rather than what students do. Studies on conceptions of teaching are based on constructivist views of teaching and learning and try to capture range of qualitatively different conceptions of teaching. These studies are, to a large extent, predicated on the idea that conceptions govern practices of teaching (Pratt et al., 2001; Trigwell & Prosser, 1996b). According to this literature effective university teaching is about having sophisticated conceptions and facilitating student learning that involves addressing learners' holistic development and conceptual change as well as their development as professionals and independent learners. The limitation of the effective teaching literature, including both types of studies, is that use of available resources such as computer related technologies are rarely mentioned as part of teaching expertise or as means of enacting effective teaching and facilitating student learning.

The last section of the first manuscript addressed the gaps identified in the first two sections—that research on computer-based cognitive tools rarely address teaching or the role of the professor and research on effective teaching does not include computer application as part of teaching expertise or means of effective teaching. The suggested bridge is a perspective of effective teaching as the design of rich learning environments. These environments involve contextualizing the learning material (content), adopting learner- and learning-centered approaches, addressing both cognitive and social aspects of learning, and using contextual resources such as computers in a way that aligns tool use with educational rationale. Essentially, it is argued that the use of computers as cognitive tools for student learning in natural contexts necessitates combining the affordance of the tools with appropriate design of activities and contexts for learning.

The second manuscript was a follow up to the first section and had two purposes. The first was capturing the qualitatively different conceptions of effective teaching held by professors who were teaching in technology rich classrooms. The second was determining the relationship of these conceptions to the role professors see for computers in their teaching. These objectives were motivated by the need to understand whether or not conceptions of effective teaching are context specific and whether having context specific view of effective teaching is related to use of computers that are available in the teaching and learning context. Using a semi-structured interview with professors who self-selected to teach in active learning classrooms the study captured three conceptions of effective teaching—transmitting knowledge, engaging students, and developing learning independence or self reliance. Similar to findings generated by previous studies (Samuelowicz & Bain, 1992; Saroyan et al., 2009; Trigwell & Prosser, 1996b), the result revealed that professors who considered effective teaching to be transmitting knowledge believed that subject matter understanding is the main outcome for students and effective teaching is organizing the subject matter and presenting it clearly to students. These professors reported using instructional strategies that were teacher oriented including advanced planning, coherent presentations, and question and answer periods.

Professors who considered effective teaching to be engaging students emphasized participatory and social aspect of student learning as additional elements to subject matter understanding. These professors expected their students to develop presentation skills, work with others, and be active participants. Their instructional strategies reflected their conceptions as they were seen to be instrumental in building classroom environments for students to participate in discussion, presentation, group work, and role playing. In addition some professors in this group emphasized the need for hands on experience for students and their engagement with the tools and exercises.

Professors who viewed effective teaching to be developing students' learning independence focused on providing the environment and opportunities for students to become self reliant in their learning. These professors described effective teaching in terms of students' a) holistic development, b) metacognitive awareness and learning independence, c) learning through practice and problem solving, d) use of appropriate tools. They reported using a combination of collaborative and individual learning strategies including group projects, independent problem solving, summarizing articles, and judicious use of computer related tools. Essentially, professors in this group manifested conceptions of effective teaching related to designing environments for student learning and engagement as identified in the first manuscript.

A new finding in this study was the relationship between professors' conceptions of effective teaching and their reported use of computers in their teaching. At one end of the continuum, professors with knowledge transmission view of effective teaching considered computers and related technologies in the classroom to be tools for accessing information and making presentation. At the other end, professors whose conception of effective teaching was related to designing learning environments considered computers to be an integral part of their course to develop students' learning independence and problem solving abilities. In the middle were professors with conceptions of effective teaching as engaging students. The role these professors saw for computers is in line with how they view student engagement. Three professors view effective teaching as student engagement through participation, discussion, presentation, collaboration. These professors attributed a lesser role for computers in their teaching and preferred the special set up the active learning classrooms provide. Two other professors expressed effective teaching as student engagement in terms of hands on experience and dealing with modeling exercises. Thus, they perceive better role for computers in terms of data analysis and problem solving.

The third part of this dissertation extended the findings of the second study and examined the relationship between professors' conceptions of effective teaching (including the role they see for computers) and student engagement at course and classroom level. This study was motivated by two related ideas: a) student learning is about their active involvement in the process (Astin, 1984; Kuh, 2001; Marks, 2000), and

b) learning environments substantially influence the nature and extent of students' engagement and their development of essential competencies (Fraser, 1998; Kember & Leung, 2009). The first part of this study dealt with the development of an instrument for determining and assessing student engagement in technology rich classrooms. The "student Engagement in Technology Rich Classrooms (SETRC) survey", was developed to reflect constructivist perspective and student-centered approaches to teaching and learning, cognitive and social aspects of engagement, and technology orientation to the learning environment. Responses to the items were designed in a way that represents the continuous nature of student engagement in the learning experience stated in the item rather than just the presence or absence of engagement (Astin, 1985).

Item-total correlation and principal component analysis (PCA) resulted in a 19-item instrument with four scales or aspects of student engagement: cognitive and applied engagement, social engagement, reflective engagement, and goal clarity. The instrument has overall reliability of Cronbach's alpha (α) .87. Reliability for the four scales ranges from acceptable (.65) to high (.86) and the four components explained 55% of the variance in student engagement.

Having determined the nature and extent of student engagement in technology rich classrooms, this study also examined the relationship of student engagement to professors' conceptions of effective teaching. Component scores were first calculated for each student representing the amount of score students would have received if they were measured on the components themselves (Tabachnick & Fidell, 2007). This was followed by a multivariate analysis of variance (MANOVA) that considered conceptions of teaching (three levels) as independent variable and the four components of engagement as dependent variables. Results of the analysis revealed expected direction of relationship between the first two components—cognitive and applied engagement and social engagement—and professors conceptions of effective teaching. That is, mean scores of students for cognitive and applied engagement were significantly different among the three groups of professors' conceptions. Students in classrooms of professors who viewed effective teaching as developing learning independence reported the highest engagement followed by students in classrooms of professors with conception of effective teaching as engaging students. Students in knowledge transmission view of effective teaching reported the least cognitive and applied engagement score.

Social engagement scores were in line with the findings of the second study in that students in classrooms of professors with student engagement views of effective teaching reported the highest score on social engagement compared to the other two categories. However, this score was significantly different only from scores of students in knowledge transmission group but not from developing learning independence group.

Contributions of the Study

This study contributes to both practice and research. First, it helps to reconceptualize effective teaching in terms of designing context sensitive learning environments rather than understanding it in terms of what professors do in relation to organizing and presenting content for students. Effective teaching as design of learning environments also involves judicious use of computer related tools and other contextual resources. If professors experience such a shift in conceptualization of effective teaching, it is possible that university classrooms become places where learning takes place rather than places where teaching takes place (Barr & Tagg, 1995).

The relationship between professors' conceptions of effective teaching and the role they see for computers in their teaching as well as the subsequent relationship between teaching conceptions and student engagement has implication for faculty development programs. Faculty development programs that involve use of computers for teaching and student learning need to also focus on addressing changing professors' conceptions of teaching and designing learning environments together. The finding also brings to the fore the role of professors in designing learning environments and technology appropriation for student learning and active engagement.

The components of student engagement that emerged from the instrument and the results of the principal component analysis will also inform professors and instructional designers as to what student engagement at course or classroom level entails. These findings can also inform administrators who provide resources for the acquisition and provision of computers to facilitate student learning about the fact that physical resources make up only part of the learning environment and that there is a need to work on other aspects such as faculty development and student engagement issues concurrently.

This study has extended existing research in two ways. First, it has captured professors' conceptions as it relates to a specific context and specific course. Previous research on conceptions of teaching was based on general reflections about teaching without necessarily focusing on the context which could inform decision making related to planning and selection of instructional strategies (Eley, 2006; Kane et al., 2002). The professors in this study whose conceptions of effective teaching reflected elements of design of learning environments were relatively more context sensitive and designed their teaching in a way that utilized available resources including computers and other tools (e.g., round tables).

This research also bridges three areas of research — conceptions of teaching, student engagement, and learning environments. Student engagement has been researched at institution (Hu, 2011; Kuh, 2001, 2003; NSSE, 2008 Report) and program (Kember & Leung, 2009) levels, but not at course/classroom levels and not in technology rich natural contexts. The instrument developed for this research can be a useful tool for assessing student engagement at the level and context, an aspect that has not been addressed by previous research and in a way that informs professors and instructional designers. Quantitative ways of examining learning environments has so far focused on capturing students opinions on different aspects of the classroom context and actions of professors rather than what students themselves do (Fraser, 1998; Fraser et al., 1986). More specifically, the widely used survey, college and university classroom environment inventory (CUCEI) (Fraser et al., 1986) has been challenged for its lack of constructivist perspective and technology orientation (Logan, Crump, & Rennie, 2006). The student engagement in technology rich classrooms (SETRC) survey focused on cognitive and social aspects of student engagement and what students report about the activities they do using computers for their learning.

Future Research

Based on the findings of this dissertation, three areas of possible research can be suggested. The first is understanding the context-specific nature of teaching conceptions and the relationship of the conceptions to designing environments for student learning and utilization of available resources. Eley (2006) took a step in that direction by examining how conceptions are related to planning of teaching and related decision making. Eley's study concluded that teachers' thinking was related to contextual issues and models rather than generalized conceptions. However, participants were not directly asked about their conceptions. Instead, the 29 participating professors were asked to describe a specific episode of their teaching and its related antecedents. It is likely that they ended up describing the specifics of that episode and the reasoning behind it rather than evoking or mentioning their conceptions about (effective teaching). Thus, future research needs to take large number of participants and interview them about their conceptions in the context of a specific course or classroom and explain how their conceptions inform their planning and decision making. The data can be complimented by classroom observations and student responses.

The second area of research relates to the validation of the instrument used. One of the limitations of this study is the relatively small number of student participants and its exploratory nature. Considering the importance of student engagement as a means of student learning or an end by itself (Shulman, 2002) and the proliferation of technology rich classroom based learning environments, developing an instrument that can capture the nature and extent of student engagement will be of high significance. Thus, subsequent confirmatory study needs to be conducted with more items on the last two factors and large number of participants.

The third area of research can be relating the extent of student engagement to measures of actual learning. This points to another limitation of the present study, the use of self reported data. Though acceptable, such data are about students' perception of what they do using the computers in relation to their learning, and students' actual learning is not measured. Examining the relationship of student engagement to measures of actual learning can reveal useful information for professors and instructional designers.

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Appendix A

Interview protocol for professors

0. Some introductory questions (what course are you teaching, teaching experience, whether or not the professor is using Room 627 for the first time...)
1. What is good teaching for you in your (this) course, how do you characterize it?
2. What is it that you expect students to learn from your (this) course?
3. In your teaching, when do you feel you contribute to or influence student learning? What do you consider as evidence?
4. What role do you see for computers and related tools in realizing (practicing) your view of good teaching? In what ways do computer tools help you achieve the teaching you want to do? How about the classroom setting?
5. In what ways do you think students contribute to the course and/or to their learning?
6. Was it your choice to teach in ALC or it is because you are assigned there?
7. Would your view of good teaching be different if you were teaching in other (normal) classroom rather than 627?
    a. Or another course in the same room? Can you give me examples?
8. What computer related tools do you use in your teaching (this course) in 627?
9. For what purposes do you use these tools?
    a. Which tool do you use when?
10. In relation to your course, what do you expect learners to know about computers (What kind of possible application is expected)?
11. Can you describe for me what your typical classroom (lesson) looks like when you use a computer tool in your teaching? How do you frame your tasks and the roles of students in the process?
12. How do you think your students perceive your use of this computer tool in classroom? Do you think they feel they are learning well because of the computer tool or they think the learning would be the same if you were teaching without it?
13. What is your view of the ALC in general?
14. What, if any, challenges do you face while teaching in 627?

Appendix B

Student Assessment of Learning in Technology Rich Classrooms
Department of Educational and Counselling Psychology
McGill University

Instruction to Respondents

This instrument is designed to assess your perception of learning in active learning classrooms which involves use of computers and related tools. There are two parts in this questionnaire. The first part asks general personal information (age, gender, field of study, level of study, etc.). The second part is related to your experience in taking a course in this active learning classroom. Please consider this specific course while answering all the questions (That is, do not draw your answers from other courses you took in this or other active learning classrooms).

Part I: Please circle your choices or write your answer on the blank space

1. ***Just for identifying the paper,*** please write the last four digits of your phone followed by initials of your first and last names (e.g., 1090EG): ________________________
2. Gender: A. Female B. Male
3. Your age is:
   A. Under 20 B. 20-25 C. 26-30 D. 31-35 E. 36-40 F. Over 40
4. Your field of study (Department) is:
   ____
5. The title of this course is: ____
6. You are enrolled in: A. Undergraduate program B. Graduate program
7. Is this your first course in active learning classroom? A. Yes B. No

Part II: The following are learning related statements that you might have experienced while taking this course in the active learning classroom. Please read each of the statements carefully and circle the number on the right that corresponds to your answer. (***Key***: 5-you experienced the activity implied by the statement always, 4-often, 3-sometimes, 2-seldom, 1-never)

In this course	*Never*	*Seldom*	*Some times*	*Often*	*Always*
1. The professor is sensitive to my learning background and learning goals	1	2	3	4	5
2. Classroom learning activities rely only on textbooks	1	2	3	4	5
3. The classroom allowed me to think loud (expression of ideas, procedures, algorithms, answers, etc. in the classroom)	1	2	3	4	5
4. Class sessions are not well organized in a way that involves computer use	1	2	3	4	5

In this course	Never	Seldom	Some times	Often	Alwa ys
5. I engage in online, out of class discussion related to the course with my classmates	1	2	3	4	5
6. The learning activities have practical dimension (involve learning by doing)	1	2	3	4	5
7. I engage in meaning making and constructing knowledge about the course	1	2	3	4	5
8. Group work and discussion are major components of classroom activities	1	2	3	4	5
9. The professor spends most of the class time lecturing the content	1	2	3	4	5
10. I have the opportunity to choose assignments and projects to work on	1	2	3	4	5
11. The professor is sensitive to my learning needs and interests	1	2	3	4	5
12. Classroom activities involve individual problem solving occasions using computers	1	2	3	4	5
13. I can easily see the possible application of what I learned in this course to work place settings	1	2	3	4	5
14. Classroom use of computer supports my efforts to achieve the goals (of learning this course)	1	2	3	4	5
15. Classroom activities and discussions in general are related to real world situations	1	2	3	4	5
16. I engage in analysing information, comparing and contrasting ideas using computers	1	2	3	4	5
17. I engage in reflecting on my learning	1	2	3	4	5
18. Course materials are related to learning goals	1	2	3	4	5
19. I engage in representing my understanding of concepts using computers	1	2	3	4	5
20. I cooperate with other students while working on assignments	1	2	3	4	5
21. Originality of ideas are encouraged in classroom discussions	1	2	3	4	5
22. I interact with other students in the course using emails and WebCT	1	2	3	4	5
23. The learning goal is clearly communicated in each session	1	2	3	4	5

In this course	*Never*	*Seldom*	*Some times*	*Often*	*Alwa ys*
24. What I learned in this course is or can be related to what I learn in other courses	1	2	3	4	5
25. I engage in discussion with other students on the same table	1	2	3	4	5
26. I am aware of the purpose(s) of each classroom session	1	2	3	4	5
27. I communicate with the professor using emails and WebCT	1	2	3	4	5
28. Students use multiple sources of information (Internet, references, etc.)	1	2	3	4	5

29. If the course was taught in a different (normal) classroom (other than this active classroom), how would your learning be different?

    A. It would be better B. It would be the same C. It would be less

30. How would you generally rate the quality of teaching in this course?

    A. 90-100 B. 80-89C. 70-79 D. 60-69 E. 50-59 F. Below 50

31. How would you generally rate the professors' use of computers and related tools in this course?

    A. 90-100 B. 80-89C. 70-79 D. 60-69 E. 50-59 F. Below 50

32. How would you generally rate your use of computer and related tools for your learning of this course?

    A. 90-100 B. 80-89C. 70-79 D. 60-69 E. 50-59 F. Below 50

If you have additional ideas, please write below

____

____

____

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Thank you for your cooperation