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Conceptions of Effective Teaching and Perceived Use of Computer Technologies in Active Learning Classrooms

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This paper examined professors' conceptions of effective teaching in the context of a course they were teaching in active learning classrooms and how the conceptions related to the perceived role and use of computers in their teaching. We interviewed 13 professors who were teaching in active learning classrooms in winter 2011 in a large research university in Canada. The interviews captured what professors consider effective teaching, expected learning outcomes for students, instructional strategies and the role participants saw for computers in their teaching. Analysis of interview transcripts using a holistic inductive and constant comparison approach resulted in three conceptions of effective teaching: transmitting knowledge, engaging students, and developing learning independence. Professors' perception about the role and use of computers was found to be in line with their 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. Data collected from students about their use and their professors' use of computers in the course supports this conclusion. Results have implications for design of active learning environments and faculty development initiatives.

Serious conversations that delve into the value added dimension of the use of computer related technologies in education largely attribute the value to the design of learning activities and environments rather than to the presence of these tools or their special features per se. Learning activities need to be designed in ways that elicit active engagement of learners and allow for judicious use of tools in the process (Jonassen & Reeves, 1996; Kim & Reeves, 2007). Effective design of learning activities are typically theoretically grounded, context-oriented, and aligned with learning-centered approaches to teaching (Hannafin, Hannafin, Land, & Oliver, 1997). However, the design of such environments is influenced by various factors, one of which is professors' conceptions about effective teaching.

We know from the literature on university teaching that the conceptions professors hold about effective teaching influence their choice of instructional strategies and teaching practices (Entwistle & Walker, 2000; Trigwell, Prosser, & Taylor, 1994). This literature, however, does not provide insight into how professors' conceptualization of effective teaching relates to the perceived role and use of computers in their teaching. This gap in our understanding can be attributed to the independent evolution of two bodies of literature: conceptions of effective teaching and the use of computers in teaching and learning. Research on effective teaching has typically focused on understanding professors' conceptions of teaching and determining traits and activities attributed to effectiveness. Likewise, empirical and meta-analytic research on the use of computers in university teaching have largely focused on determining the "effects" of computers on student achievement (Fried, 2008; Schmid et al., 2009). In most cases, the educational rationale behind the use of computer related tools and the importance of the socio-technical context have been, at best, implicit and often assumed. As part of a research project that investigated the use of computers in active learning, technology-rich classrooms from the perspectives of professors and students, the study reported in this paper addressed three questions: (1) What is effective teaching for professors who teach in active learning classrooms? (2) What role do professors see for computer related tools in enacting their view of effective teaching? (3) In what ways are professors' conceptions of effective teaching related to the perceived role and use of computers?

A persistent criticism voiced in the last three decades concerning computers in university teaching and learning has been that computers reinforce traditional methods of teaching instead of promoting more learning-oriented teaching approaches (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 U.S. 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, Selwyn (2007) suggested the need to understand non use of computer technologies in higher education teaching and learning and to shift the discourse from a macro-level study of "barriers" to a micro level understanding of individual, psychological and educational rationales. The effect of computer use in teaching and learning is context-dependent in that the 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.

Context and Active Learning Classrooms

Context provides a frame or "field of action" within which effective teaching is embedded (Duranti & Goodwin, 1992). It represents the weaving together of social, psychological and technological aspects in a way that situates the learning experience and provides coherence for the teaching and learning process (Gilbert, 2006; Van Oers, 1998; Windschitl, 2002). At a broader level, context could refer to the societal culture under which teaching and learning takes place (Devlin & Samarawickrema, 2010; Pratt, Kelly, & Wong, 1999). For example, Pratt et al. (1999) employed a qualitative survey and collected data from 397 students and 82 Chinese and expatriate faculty at Hong Kong Chinese University to examine the ways effective teaching is conceptualized and enacted. The researchers reported that expatriate faculty members' conceptions of effective teaching were different from Chinese faculty and students. The notable difference was in participants' expression of the role and value of foundational knowledge in undergraduate education, the roles and relationships of faculty and students, the teaching processes and the attribution of responsibility for effective teaching. Pratt et al. (1999) concluded that conceptions of effective teaching reflected "the cultural, historical and social structures within which they are enacted" (p. 251).

Context at a course or classroom level, as elaborated by Van Oers (1998), is a "meaningful situation," a situation that makes sense in relation to the "focal event" being undertaken: in this case, the teaching and learning process. Accordingly, context at classroom level has four aspects (Duranti & Goodwin, 1992; Gilbert, 2006). The first is the setting that includes the social and spatial framework within which the teaching and learning is enacted. The second is the activity structures and the extent of student engagement in learning-related activities that facilitate their cognitive and behavioral development. Tools are the third dimension of context as they mediate learners' active engagement. However, effective use of tools depends on what goals are to be accomplished. Tools such as computers lend to students the expertise of designers and previous users and help them in processing information, externalizing thoughts and creating representations. The fourth aspect is the extra-situational context that extends beyond, but relates to, the classroom context and processes. For example, previous knowledge or background of students as well as their career plans and expectations could shape or interact with the current teaching and learning situation.

Active learning classrooms (ALC) are instances of technology-based classroom contexts that afford rich environments for active learning, collaboration and engagement (Grabinger, 1996). They are often established with the purpose of integrating technology, facilitating active student learning, and improving teaching practices (Pundak & Rozner, 2008). ALCs are also considered as means of implementing constructivist teaching and learning principles with the goal of helping students construct and integrate knowledge and, in so doing, achieve higher level thinking and problem solving capabilities (Grabinger, 1996; Kovalchick & Dawson, 2004).

Various universities in the US and Canada have introduced active learning classrooms to enhance the learning experiences of students. The Technology Enabled Active Learning (TEAL) at Massachusetts Institute of Technology, the Student-Centered Active Learning Environment for Undergraduate Programs (SCALE-UP) at North Carolina State University, and the Active Learning Classroom (ALC) projects at the University of Minnesota and McGill University are examples of such classrooms (Dori & Belcher, 2005). In most cases, traditional classrooms are completely redesigned to provide the social setting and collaborative context that can enhance students' active participation. In addition, the technologies available in the classroom enable the students to put to use the considerable experience and knowledge they have of computers and related technologies to foster deep learning. In summary, active learning classrooms afford professors a unique environmental context to design their instruction in a way that uses computers as learning tools. However, the design of learning activities could also be influenced by other factors such as their conceptions of effective teaching (Trigwell & Prosser, 1996) and the perceived usefulness (Davis,

1989) of available technological resources in enacting their version of effective teaching.

Context and Effective Teaching

Several researchers have represented effective university teaching in relation to aspects of student learning (e.g., Abrami, d'Apollonia, & Rosenfield, 2007; Biggs, 2012; Carnell, 2007). However, "effectiveness" is a problem-driven rather than theory-driven construct (Cameron, 1986), and, as such, no single theory or criterion can adequately explain or represent it because definitions and measures vary from one context and/or constituent to another.

Researchers have questioned the universality as well as practical applicability of effective university teaching representations primarily because rarely is there a consideration of context related factors (Berk, 2005; Carpenter & Tait, 2001; Devlin & Samarawickrema, 2010; Eley, 2006; Kane, Sandretto, & Heath, 2002). For example, Berk (2005) has asserted that from a 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. It can thus be asserted that the central element of effective university teaching is meeting the requirements of the context in which the teaching and learning takes place.

The logical extension of the above assertion and one that several researchers have supported is that teaching conceptions are also relative and context specific (Cole, 1990; Entwistle, Skinner, Entwistle, & Orr, 2000). However, professors' conceptions of effective teaching have rarely been examined in relation to a specific course or in active learning classrooms where technological resources are used in teaching. Understanding how professors conceptualize effective teaching in a specific classroom or course context and how their conceptions relate to their perceived use of computer related tools is important for two reasons. First, as suggested in the broader technology implementation literature, the consistency and quality of use of innovative facilities such as active learning classrooms is a function of their alignment with the values and perceptions of the users (Klein & Sorra, 1996). "Perceived usefulness"— the extent to which users believe a given technology can help them 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, Morris, Davis, & Davis, 2003). This translates into how professors perceive what teaching in such contexts entails and the role computer-related tools can play in achieving effective teaching and student learning.

Second, there have been persistent concerns about the general nature of descriptions of effective teaching in the literature on university teaching and the extent to which these descriptions and reported conceptions of effective teaching reflect or relate to professors' practices and decision making with respect to the instructional strategies they use (Carpenter & Tait, 2001; Eley, 2006; Kane et al., 2002). This is because 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 process. Responses, not surprisingly, reflect general views and omit the nuances that are best understood when both the questions and answers are situated within a specific context. Because of the nature of questions asked, reported conceptions could be broad opinions or "*post hoc* reflections" on past experiences and may have little to do with actual classroom practices or specific plans and decisions related to teaching in a specific context (Eley, 2006; Kane et al., 2002). It is therefore imperative that we consider these contextual factors in conceptualizing as well as assessing effective university teaching.

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 related to their and their students' perceived use of computers in the course.

Methods

This study employed a multiple case study approach (Yin, 2003) with the purpose of understanding perceived technology use in relation to conceptions of effective teaching. Stake (1995) refers to this genre as instrumental case studies and recommends the genre's use 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 was a course taught in an active learning classroom.

Context and Participants

The research site was a large research 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) can accommodate 72 students seated 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 seated 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 computer with screen access/sharing facilities. Both rooms were converted from their traditional design to accommodate the technological infrastructure and to support collaboration and interaction.

Participants for the study were 13 professors and their students (N = 232). Two faculty were lecturers (non-tenure track), and the rest held a rank of at least assistant professor. Table 1 presents the list and level of courses, attendance, and teaching experience of the professors. Participating professors constituted 68% of the professors who were scheduled to teach in the two active learning classrooms in winter 2011. All professors started teaching in the active learning classrooms by choice, and only two were using the classrooms for the first time.

Data from professors was collected using semi-structured interviews that took place between the third and tenth week of the 13-week term in their respective offices except in two cases where the interviews were conducted in the office of the first author for greater convenience. Interviews were based on seven questions, which lasted 50 minutes on average, and were audio-recorded. Interview questions focused on professors' views of effective teaching in the specific context of the course taught in the active learning classroom in that particular term, expected outcomes for students, their instructional strategies, the role they saw for computers in their teaching and in realizing their instructional goals, and the type of applications they used.

Following the interviews with professors, their students were asked to respond to three questions: (a) whether their learning would have been better, the same, or less if the course had been taught in a traditional classroom, (b) their professor's use of computers in teaching, and (c) their own use of computers for learning in that specific course. These questions were appended to the Student Engagement in Technology Rich Classrooms (SETRC) survey (Gebre, Saroyan, & Bracewell, 2014). Sixty-five percent of students who were attending the classes of the 11 professors consented to participate with almost equal gender composition and 65% undergraduate and 35% graduate enrollment.

Data Analysis

All interviews were transcribed verbatim. Professors' descriptions were 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 or idea units (Aulls, 2004; Krull, Oras, & Pikksaar, 2010; 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. Butterworth (1975) has 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 the descriptions provided by 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 the professors' descriptions of effective teaching, their expected learning outcomes, and their instructional strategies were not clearly differentiated at times. When segments from one description appeared to be similar in meaning to segments in other descriptions, 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 represented about each professor's conceptions of effective teaching.

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; when it was different, a new category was created (Samuelowicz & Bain, 1992). This required considerable iterative review of units of meaning, generated categories and original transcripts to represent professors' views as accurately as possible. Coding was done by the first author. For reliability, a professor emeritus who is an established qualitative researcher was

Table 1
List of Courses and Professors' Experience

Course	Field of Study	Level	Class size	Prof. Exp. (years)
Analysis of sustainability	Geography	300	18	6
Aristotle	Philosophy	300	42	22
Behaviour in organizations	Management	500	48	19
Earth systems modeling	Geography	300	14	6
Electromagnetic waves	Physics	300	28	10
International human rights law	Law	500	55	5
Advanced methods in TESL	Language	400	41	36
Modeling environmental systems	Geography	500	38	27
Remote sensing and interpretation	Geography	500	16	3
Raster geographic information systems	Geography	300	30	5
Writing for graduate students	Language	600	28	16
Signals and systems	Ele. & Comp. Engineering	300	NA*	6
Human dimensions of climate change	Geography	400	NA*	3

Note. Professors opted out of the active learning classroom and student data was not collected.

briefed about the coding procedure and asked to code segments of nine professors' responses on effective teaching using the established categories. After discussion, there was 89% agreement between the two coders. The analysis helped us examine the consistency of responses within a case and to compare responses between cases.

Results

Conceptions of Effective Teaching

Professors' descriptions of effective teaching were grouped into three categories based on expressed intentions and whether or not the emphasis in the description was on activities related to the teacher or student. Intentions, in the literature, is described as "representations of future courses of action" (Bandura, 2001, p. 6) and intentionality is the "essence of teaching" (Garrison & Macmillan, 1994, p. 386) as it prompts professors to adopt a given teaching strategy (Trigwell & Prosser, 1996). The emerging three categories of effective teaching were: a) a teacher-centered activity, b) an engagement-centered activity, and c) a learning and development-centered activity. Table 2 presents these 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. Expressed learning outcomes were categorized into subject matter (content) understanding, skills development and learning independence. Table 3 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 the teacher-centered category, professors' descriptions of effective teaching emphasized students' learning of content or understanding of the subject matter. Views captured in this category suggested that there is a pre-planned content and structure of the subject matter that learners should understand. Thus, the meaning of effective teaching appeared to be related to organizing and explaining pre-determined content in a way that would foster students' understanding. The emphasis in this category was on teacher-related activities and the amount or quantity rather than the quality of student learning. Within this context, the expected learning outcome for students at the end of the course was developing subject matter knowledge. The following excerpts are selected 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 (P004).

> [Effective teaching] would be giving instructions to the students on a particular concept; and giving examples of application. And, having students doing examples of that on their own would be good (P009).

Table 2
Descriptions of Effective Teaching

Prof.	Category 1 (Teacher-centered)	Category 2 (Engagement-centered)	Category 3 (Learning and development-centered)
P001	Making the subject clear to students		
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 learn. They should learn as much as possible		
P005		Engaging students with the material, providing opportunities for hands on experience, engaging in discussion, making presentations	
P006			Students learning through practice; working as independently as possible; solving their own problems
P007		Generating debates, encouraging participation, empowering students	
P008			Students using tools to address sustainability issues; interpreting results
P009	Giving instruction and examples of application		
P010		Creating dynamic class environments; understanding challenges students run into; following their progress	Students working on modelling; providing instant feedback to them when they are faced 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 3
Expected Learning Outcomes

Prof.	Category 1 (Subject matter understanding and application)	Category 2 (Skills development)	Category 3 (Strategies and learning independence)
P001	Knowledge about [the subject]		
P002		Understanding key debate issues and policies on climate change; assessing the impact of climate change; developing skills to get involved in discussions	
P003	Understanding of theories and their impact	Working effectively in teams, managing self, participating	
P004	Understanding defined content and aspects of the subject; solving exercises		
P005		Calibrating and analyzing data; being proficient in software tools (ENVI & Math lab)	
P006		Being proficient in the software	Dealing with technical solutions to geography problems; being an independent learner; approaching and solving problems
P007*			
P008			Understanding logic and performing conceptual analysis; understanding what goes on behind the software; selecting and using tools
P009	Developing knowledge of mathematical tools, the main concepts		
P010			Building models; ways of approaching problems, systems thinking; applying models
P011			Developing strategies; having a better sense of their own abilities; having learning independence
P012		Writing equations, solving exercises using models	
P013			Knowing how to develop a syllabus, aligning teaching materials and techniques; having competencies required by Ministry of Education

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

Descriptions in Category 2 primarily focused on engaging students in the learning process and with the course materials. Students were expected to acquire subject matter knowledge but through participation and interaction rather than through the professor's presentation. Engaging students was manifested in different forms such as students making presentations and participating in class discussions, professors considering students' needs and backgrounds and adjusting their teaching to meet the level of students, creating a dynamic classroom environment, and actively encouraging student participation.

These descriptions and outcomes differ from those in Category 1 in that the purpose of effective teaching extends beyond making the content clear for students. Considering the phrases used by participating professors, such as "engaging students" (see P002 below), "encouraging participation" and "empowering students" (P007), it could be said that these descriptions are more process and interaction oriented where students have relatively more control and responsibility. Expected outcomes involved subject matter knowledge as well as the development of social and cognitive skills. The following excerpts are selected examples of this category.

> 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 [for] 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 (P005).

The third category consisted of descriptions of effective teaching that extended to students' holistic development (see excerpt from P013 below), the ability to work independently (P006, P011, P013), and the use of relevant tools (P008). Professors in this category viewed 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 was developing students' independence and self-reliance in learning. This was also mirrored in the descriptions of expected learning outcomes. Professors expected their students to deal with technical solutions (P006), understand the logic behind what software do (P008), develop ways of approaching problems, and produce artifacts in the form of models and teaching materials (P010, P011, P013). Professors (P010 and P013) also maintained that as it is not possible to prepare students for every possible scenario in the work place or in 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. . .we cannot prepare people for every single eventuality (P013).

> I approach the course in a quite loose was. . . 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 have. . . 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 Tables 1 and 2, we named the three conceptions of effective teaching as *transmitting knowledge* (Category 1), *engaging students* (Category 2), and *developing students' learning independence/self reliance* (Category 3). These categories are not mutually exclusive in the sense that a higher category (e.g. Category 3) may include descriptions of a previous category or categories (1 or 2), suggesting a hierarchical relationship between the categories. In the subsequent sections, we compare these three conceptions in terms of the professors' instructional strategies and the perceived role and/or use of computer related technology in their teaching.

Instructional Strategies

Instructional strategies consist of a series of decisions and plans and a variety of related teaching activities that are aimed at achieving intended outcomes (Dick, Carey, & Carey, 2001; Jonassen, Grabinger, &

Harris, 1991). We examined the instructional strategies used by participating professors for two purposes: to check how instructional strategies differ in relation to conceptions of effective teaching and to see how instructional strategies related to the way professors' perceived the role and use of computers in their teaching.

The comparison of instructional strategies revealed a difference in the extent of control the described strategies give 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). Results are presented in Table 4. Professors in the transmitting knowledge category 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. Descriptions largely focussed on what the professor does 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. . .I stop regularly and ask if they have any questions to make sure that what I have said is clear. . .I have assignments that are very short again with very specific instructions (P001).

> . . .lectures. . .[Students] can ask questions, we do exercises together. I ask a lot of questions. . .I have all the notes on the web. . .I use the web to have my notes on and it is accessible with password. 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. . .you give it entirely step by step. . .it needs to make a nice story at the end (P009).

In the engaging students category, instructional strategies identified by professors were participatory and focused on students' engagement with course materials as well as their interaction with each other and with the professor. This included reading assigned materials and making presentations, often followed by question and answer sessions, group work involving working on problems and cases in groups and in and out of class, and making presentations.

> [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).

> … 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 (P002).

> ...with [the] round tables and chairs [students] are very used to discussion. They are also very open to ask questions… And then we move on to our activity (P003).

Professors in the developing learning independence category reported relying less on straight lecturing and more on employing strategies that involved practical exercises, problem definition, independent work and model-building. Students worked on summarizing articles, choosing their own projects and defining parameters independently.

> . . .for each module, they work on lab assignments…We essentially help them quite actively. . .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…to set boundaries for their problem (P008).

> We look at strategies, ways of learning and really helping [students] in their metacognitive awareness. [We use] 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. . .they have to put themselves in a kind of metacognitive state. . . So, they need to be able to feel what the problems are (P013).

Roles of Computers in Effective Teaching

Professors in the transmitting knowledge category used computers primarily for making presentations and accessing information. For example, Professor 001 stated, "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

Table 4
Instructional Strategies

Prof.	Transmitting knowledge	Engaging students	Developing learning independence/ self-reliance
P001	Having clear plans; asking questions; requiring discussion questions; planning specific assignments		
P002		Group projects; student presentation with question & answer, role playing, debates	
P003		Using cases; providing support, group projects & presentations	
P004	Putting all notes on WebCT; using clicker questions	In-class group problem solving	
P005	Changing assessment to open-ended questions	Reading and presentation with Q & A; lab assignments, hands on exercise	
P006	Lecturing	Group exercises, class interaction	Loose approach to teaching, independent work; making TA support available; allowing students to 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;	
P008	(Guest) lectures	discussions; 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	Lecturing	Being approachable; encouraging questions; team teaching; creating dynamic environment	
P013		Doing the activities in class together; providing feedback	Students developing materials; asking students to evaluate their work, to redo, and to reflect

used animations (physics applets) from the Internet, stated, "I use [the 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 his 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 as having 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 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 PowerPoint 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 computers to be "really crucial because it is modeling and modeling is by definition on a computer."

Professors in the learning independence/self-reliance category perceived computers as tools for learning and student development. 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, "…[O]ne 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.

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, a software that is used to access and analyze language from a database (corpus) to help students develop the skill of academic writing. Her justification for using this software was that language teaching has moved "away from teaching vocabulary in isolation"; 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 [Concordancer], I think, is really judicious use of a computer tool. . .it really helps people to become independent" (P011).

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 with actual data and doing problem solving. So they cannot do that without computers." 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 knowledge due to differing 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, maneuver 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." 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 modeling 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.

Student responses to three questions related to what their learning would have been if the course had been

taught in a traditional classroom, their professor's use of computers in teaching, and their use of computers in learning are presented in Table 5. As indicated in the table, a large number of students (43%) in the classes of professors with the knowledge transmission view of effective teaching considered that their learning would have been the same or better if the classroom had not been an active learning classroom. In other words, these students could not see the importance of the affordances of the classroom. Only 27% and 8% of students in classes of professors who consider effective teaching to be engaging students and developing learning independence, respectively, believed that their learning would have been the same or better if the classroom had been different.

Perceived use of computers by students and professors was also considerably different between the three groups as shown in Table 5, and this difference corroborates the qualitative data described above. That is, compared to the other groups, a larger proportion of students in classes of professors with conceptions of effective teaching as developing learning independence reported that they and their professors use computers highly in teaching and learning of the course. Table 6 presents an overall picture of the three conceptions of effective teaching generated from professors' description, the expected learning outcomes, the instructional strategies professors employed, and the role professors perceived for computers in enacting their views of effective teaching.

Discussion

The categories of conceptions of effective teaching identified in this study are somewhat similar to reported categories in the literature (Kember, 1997; Kember & Kwan, 2000; Ramsden, 2003; Trigwell & Prosser, 1996). 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 third, 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. Our data do not support Kember's (1997) latter assertion. None of our five professors in the developing learning independence category 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 artifacts (e.g., teaching materials, models), and developing learning strategies and metacognitive awareness. One reason for this discrepancy can be that Kember (1997) drew his conceptual change category largely 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, which was not the case in our study.

Even though the 11 professors who used the active learning classroom think their teaching has changed because of the classroom, the data shows that not all professors embraced the strategic demands of learner and learning-centered teaching and responded sufficiently to the challenges of teaching in such technology infused classrooms. Some professors still use content-centered approaches. The explanation for this could be a combination of the way they conceptualized effective teaching and the lack of enough pedagogical repertoire to integrate the technologies in a way that supports student learning. Almost three decades ago, Fenstermacher (1986) suggested that research on teaching needs to have "more conceptual integrity" and should be done based on the "notion of teaching that has as its point the performance of certain kinds of tasks and activities by the student" (p. 41). Others have also echoed the notion that research and practice on teaching should consider its effect on students' learning (Barr & Tagg, 1995; Biggs, 2012; Shuell, 1993). 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, Brown, & Cocking, 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. Another is the emphasis on what students do rather than what the teacher does and the alignment of the learning activities to learning outcomes (Saroyan et al., 2004). Our findings show that there is alignment between verbalized conceptions and reported instructional activities in all three categories. However, not all conceptions and practices of effective teaching are likely to result in a qualitative change in student learning, and students don't think this either. The almost even distribution of professors among the three conceptions of effective teaching identified in this study is a reminder that more support is needed to help faculty reflect on their notion of effective teaching and pedagogical practices and to embrace the idea of developing students' learning independence and self regulation.

Table 5
Use of Computers by Students and Professor as Perceived by Students

		Learning if class was traditional		Professors' use of computers		Students' use of computers	
Effective teaching	N	Less	Better or the same	High	Medium or low	High	Medium or low
Transmitting knowledge	44	25 (57)	19 (43)	24 (55)	20 (45)	11 (25)	33 (75)
Engaging students	84	60 (73)	22 (27)	69 (82)	15 (18)	63 (75)	21 (25)
Developing independence	100	89 (92)	8 (8)	86 (86)	14 (14)	82 (82)	18 (18)
Total	228	49*	174*	179	49	156	72

**This question has five missing cases*

Table 6
Professors' Conceptions of Effective Teaching and the Role of Computer Related Tolls

Conception of effective teaching	Views of effective teaching	Expected outcome for students	Instructional strategies (and techniques)	Perceived roles of computers (tools used)
Transmitting knowledge *(n = 3)*	Making topics clear to students, giving instruction, how much students learn	Subject matter knowledge, knowledge of mathematical tools and concepts	Clear lecture plans, Q & A, discussion question from readings, putting notes on WebCT, using a coherent story	Tools for presenting and accessing information. (document camera, Internet, Power Point, WebCT, clickers).
Engaging students *(n = 5)*	Facilitating student interaction, creating dynamic environment, encouraging participation	Presentation skills, understanding debates about issues, effective team work, application of theories and principles, calibrating data	Student presentations, question and answer sessions, discussions, group projects, in-class problem solving	Two views: 1) round tables preferred over computers, 2) essential tools for data analysis and modelling (Power Point, ENVI, Stella)
Developing learning independence/ self-reliance *(n = 5)*	Encouraging students to work 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	Essential learning tools for developing independence. (Stella, web quest, *Concordancer*, spreadsheet, GIS)

Our study also showed that professors with different conceptions of effective teaching differ in terms of their perception about the role and use of computers in their teaching. Maddux and Johnson (2005) identified two types of computer use in schools that 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" (Maddux & Johnson, 2005, 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 were evident in our sample and findings. Professors with the view of effective teaching as transmitting knowledge considered computers to be presentation tools and it was primarily for this purpose that they used them. They reported using the document camera, PowerPoint, 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, modeling software (e.g., Stella), spreadsheets and web quest, among others. These types of applications are open-ended tools that students can learn and think with and express their knowledge through their use rather than tools that confine their thinking process (Jonassen & Reeves, 1996). The extent of student engagement in learning with computers was also found to be significantly different in relation to these three conceptions of effective teaching (Gebre et al., 2014). Students in classrooms of professors with the *developing learning independence* view of effective teaching reported higher cognitive engagement, followed by those in the *engaging students* category, and the *transmitting knowledge* category respectively.

The importance of professors' conceptions in guiding their teaching practices has been empirically supported in the past (e.g., Trigwell & Prosser, 1996).The contribution of the present study to this literature is the addition of the technology dimension to the equation. Our findings point to a relationship between one's view of effective teaching and the use of technology in teaching. This particular aspect has important implications for faculty development programs related to technology appropriation. Universities are making considerable investments in learning technologies. If their intent is to enhance the quality of student learning, then it behooves institutions not to assume that the availability of technological tools is a sufficient condition, to take into account the mindset of their faculty, and to provide development programs that foster conceptions of teaching that lead to learning independence (see for example Ho, Watkins, & Kelly, 2001). Whether technology helps professors in changing their conceptions of effective teaching or a change in conceptions is a prerequisite for using computer related tools in a way that makes meaningful contribution to student learning are questions that require further investigation.

One of the limitations of this study is that it employed self-reported data, and there is no evidence to show professors practice what they reported. While the addition of students' perspectives and the alignment of student responses to that of the professors' adds to the credibility of the findings, future studies could include data pertaining to classroom processes. The lack of correspondence between professors' conceptions and their classroom practices has been well documented (e.g., Kane et al., 2002). A more comprehensive study that collects data about classroom processes, related course syllabus, student survey, and interviews of professors could provide deeper insight about the educational rationale in using computer related tools. Studies in the broader area of technology adoption showed that perceived usefulness is one of the essential factors that significantly determine users' technology appropriation (Venkatesh et al., 2003). The difference in perceived use of computer related technologies by professors in their teaching and its relationship to their conceptions of effective teaching is an indication for the importance of a broader mixed method study that can inform faculty development initiatives. A design-based research that supports professors in planning and enacting their teaching in technology rich environments could also serve as a means of informing both the design of learning environments and the understanding of educational rationale and technology use in the process.

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