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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 (Authors, 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 implication on design and assessment of technology-rich learning environments and on faculty development programs involving technology use in their 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, McNaught, Mills & Lueckenhausen, 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, Brown & Cocking, 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 engage-

Practitioner Notes

What is already known about this topic

- Students' engagement is important for student learning and as indicator of quality in postsecondary education.
- Students' engagement in information technology is related to other aspects of their educational practices.
- Professors' conceptions of teaching influence their approaches and strategies of teaching.

What this paper adds

- The paper determines aspects of course/classroom level student engagement as opposed to institution level (such as National Survey of Student Engagement).
- The paper also determines the relationship between aspects of student engagement in technology rich classrooms to professors' conceptions of effective teaching.

Implications for practice and/or policy

- The study developed instrument for assessing aspects of student engagement at course/classroom level.
- It contributes to both the design and assessment of technology-rich classrooms.
- It provides insight for faculty development programs so that they consider the issue of changing conceptions of teaching especially in relation to use of tools for teaching and student learning.

ment, 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: (1) to determine the dimensions of students' engagement in technology rich classrooms and (2) to delineate the relationship between student engagement and professors' conceptions of effective teaching.

Literature review

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 activities 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) and 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; Sheard, Carbone & Hurst, 2010). Commonly used indicators, especially in the USA 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, Kuh and Klein (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 is an annual information source about the 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), it does not have the additional purpose of providing evidence or insight on 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 context 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-centred, 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 characterise teaching (Cole, 1990)—influence their teaching approaches and strategies (Kember & Kwan, 2000; Pajares, 1992; Pratt, 1992; Saroyan, Dagenais & Zhou, 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, Sandretto & Heath, 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, Skinner, Entwistle & Orr, 2000). Conceptions are "relational" descriptions or conceptualisations rather than generalisations fixed in memory (Trigwell, Prosser & Taylor, 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 degree of their student-centredness (e.g., Kember, 1997; Kember & Kwan, 2000; Samuelowicz & Bain, 1992). Features of student-centred 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-centred teaching is anchored in a number of factors: (1) understanding how students learn, (2) utilising context-based pedagogical approaches, (3) determining the capabilities and limitations of available technological resource and (4) considering practicality of the various combinations of tools and strategies to result in promoting intended learning outcomes (Hannafin, Hannafin, Land & Oliver, 1997). Research on conceptions of academics suggests that professors' use of student-centred 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-centred strategies. Saroyan *et al* (2009), in their study of the goals of teaching and related student learning, reported that teacher agency 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 life long 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 PowerPoint, 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 they facilitate discussion and interaction. The other two professors considered computers as important components of their course because they and their students use them for data analysis and modelling purposes. Students in classes of these professors use 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 use databases, web quest, spreadsheets and modelling applications such as Stella—Type II use of technologies in teaching and learning (Maddux & Johnson, 2005) or use of computers as cognitive tools (Jonassen, 2003; Jonassen & Reeves, 1996). Table 1 summarises the findings of the study.

The purpose of the present paper was to extend the findings of this study (Authors, forthcoming) on the conceptions of effective teaching and to relate professors' conceptions of effective teaching to student engagement in technology-rich classrooms. More specifically, the present study had two purposes: (1) determining dimensions of student engagement in technology rich classrooms and (2) 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

Table 1: Professors' conceptions of effective university teaching

Conception of effective teaching	*Views of effective teaching*	*Expected outcome for students*	*Instructional strategies (and techniques)*	*Roles of computer related tools*
Transmitting knowledge	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, requiring students to bring discussion questions, putting notes on WebCT, using coherent story and presenting piece by piece	Computers are tools for presenting and accessing information. Tools include document camera, Internet, Power Point, WebCT, clickers.
Engaging students	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	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	Less teacher presentation and more student independent work, group projects, summarisation of articles, students developing materials and models, working on strategies and ways of learning	Computers are essential learning tools for developing independence. Tools include Stella, web quest, concordancer, spreadsheet, GIS

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 centre 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 computer 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). 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 instrument was initially developed as a 28-item, 5-point Likert-scale survey—the scales being "Never," "Seldom," "Sometimes," "Often" and "Always." 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. 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,[1] and were from an array of disciplines including philosophy, physics, law, English as second language, geography, continuing education and electrical and computer engineering—constituting 68% of the professors who were scheduled to teach in the two active learning classrooms in winter 2011.

Following interviews conducted with professors, students 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 13 professors consented to participate and completed the paper copy of the instrument. No compensation was offered for participating in the study. There was almost equal gender composition, with 65% undergraduate and 35% graduate enrolment.

Data analysis

SPSS version 17 was used to analyse the data. In the survey missing values accounted for less than 3% and were replaced with mean imputation. 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 factors 3 and 4, which was not the case in the first extraction. Because factor 4 had only three loadings including item 19, dropping this item 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 that yielded four clear components. Bartletts' test of sphericity for the 19-item instrument was 1482 ($p < 0.001$) and Kaiser-Meyer-Olkin measure of sampling adequacy was 0.85 indicating the reliability of the principal component analysis and the compactness of the correlations to produce distinct components.

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.

Table 2: Factor loadings for principal component analysis with varimax rotation of students' engagement in technology rich classrooms

Item	Components of engagement			
	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 >0.40.

To establish the reliability and the internal consistency, we also calculated Cronbach's alpha coefficients, which yielded 0.86, 0.73, 0.67 and 0.65 for the four components, respectively, and 0.87 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 3: Mean and standard deviation of student engagement scores

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

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

The multivariate results were significant, Wilks's $\Lambda = 0.50$, $F(8, 444) = 23.41$, $p < 0.001$; 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, $F(2, 225) = 76.12$, $p < 0.001$; and in social engagement, $F(2, 225) = 17.05$, $p < 0.001$. However, there was no significant difference among the categories in students' reflective engagement, $F(2, 225) = 2.36$, $p > 0.05$ and goal clarity, $F(2, 225) = 1.06$, $p > 0.05$.

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 $p < 0.001$.

Concerning social engagement, post hoc comparisons showed that students in transmitting knowledge category reported significantly low scores ($M = 2.87$, $SD = 0.62$) when compared to students both in student engagement category ($M = 3.59$, $SD = 0.68$) and in learning independence/self reliance category ($M = 3.48$, $SD = 0.72$), $p < 0.001$. However, the difference between mean scores of students in student engagement category and learning independence/ self-reliance category was not significant, $p > 0.05$.

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 achievement 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.

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, Watkins and Kelly (2001) suggest that conceptual change attained following faculty development initiatives can result in the innovative use of technologies in teaching. Authors (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-centred 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.

Note

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

References

Bain, J. D., McNaught, C., Mills, C. & Lueckenhausen, G. (1998). Describing computer-facilitated learning environments in higher education. *Learning Environments Research*, *1*, 2, 163–180.

Bernard, R. M., Abrami, P. C., Borokhovski, E., Wade, C. A., Tamim, R. M., Surkes, M. A. *et al* (2009). A meta-analysis of three types of interaction treatments in distance education. *Review of Educational Research*, *79*, 3, 1243–1289.

Bransford, J. D., Brown, A. L. & Cocking, R. R. (2000). *How people learn: brain, mind, experience, and school*. Washington, DC: National Academies Press.

Carini, R., Kuh, G. & Klein, S. (2006). Student engagement and student learning: testing the linkages. *Research in Higher Education*, *47*, 1, 1–32. doi: 10.1007/s11162-005-8150-9.

Carnell, E. (2007). Conceptions of effective teaching in higher education: extending the boundaries. *Teaching in Higher Education*, *12*, 1, 25–40.

Chang, W. (2005). Impact of constructivist teaching on students' beliefs about teaching and learning in introductory physics. *Canadian Journal of Math, Science & Technology Education*, *5*, 1, 95–109.

Chickering, A. W. & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin*, *39*, 7, 3–7.

Cole, N. (1990). Conceptions of educational achievement. *Educational Researcher*, *19*, 3, 2–7.

Corno, L. & Mandinach, E. B. (1983). The role of cognitive engagement in classroom learning and motivation. *Educational Psychologist*, *18*, 2, 88–108.

Cuban, L. (1993). Computers meet classroom: classroom wins. *The Teachers College Record*, *95*, 2, 185–210.

DeVellis, R. F. (1991). *Scale development*. Newbury Park, NJ: Sage Publications.

Dori, Y. J. & Belcher, J. (2005). How does technology-enabled active learning affect undergraduate students' understanding of electromagnetism concepts? *Journal of the Learning Sciences*, *14*, 2, 243–279.

Entwistle, N., Skinner, D., Entwistle, D. & Orr, S. (2000). Conceptions and beliefs about "good teaching": an integration of contrasting research areas. *Higher Education Research & Development*, *19*, 1, 5–26.

Ertmer, P. (1999). Addressing first-and second-order barriers to change: strategies for technology integration. *Educational Technology Research and Development*, *47*, 4, 47–61.

Grabinger, S. (1996). Rich environments for active learning. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 665–692). New York, NY: Simon & Schuster Macmillan.

Hannafin, M., Hannafin, K., Land, S. & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development*, *45*, 3, 101–117.

Ho, A., Watkins, D. & Kelly, M. (2001). The conceptual change approach to improving teaching and learning: an evaluation of a Hong Kong staff development programme. *Higher Education*, *42*, 2, 143–169.

Hu, S. & Kuh, G. D. (2002). Being (dis)engaged in educationally purposeful activities: the influences of student and institutional characteristics. *Research in Higher Education*, *43*, 5, 555–575. doi: 10.1023/a:1020114231387.
Jonassen, D. (2000). *Computers as mindtools for schools: engaging critical thinking* (2nd ed.). Upper Saddle River, NJ: Merrill.
Jonassen, D. (2003). Using cognitive tools to represent problems. *Journal of Research on Technology in Education*, *35*, 3, 362–382.
Jonassen, D. & Carr, C. S. (2000). Mindtools: affording multiple knowledge representations for learning. In S. Lajoie (Ed.), *Computers as cognitive tools: no more walls* Vol. II (pp. 693–719). Mahwah, NJ: Lawrence Erlbaum Associates.
Jonassen, D. & Reeves, T. C. (1996). Learning with technology: using computers as cognitive tools. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 693–719). New York, NY: Macmillan.
Kane, R., Sandretto, S. & Heath, C. (2002). Telling half the story: a critical review of research on the teaching beliefs and practices of university academics. *Review of Educational Research*, *72*, 2, 177.
Kember, D. (1997). A reconceptualisation of the research into university academics' conceptions of teaching. *Learning and Instruction*, *7*, 3, 255–275.
Kember, D. & Kwan, K. (2000). Lecturers' approaches to teaching and their relationship to conceptions of good teaching. *Instructional Science*, *28*, 5, 469–490.
Kim, B. & Reeves, T. C. (2007). Reframing research on learning with technology: in search of the meaning of cognitive tools. *Instructional Science*, *35*, 3, 207–256. doi: 10.1007/s11251-006-9005-2.
Kovalchick, A. & Dawson, K. (2004). *Education and technology: an encyclopedia*. Vol. 1. Santa Barbara, CA: ABC CLIO.
Krause, K.-L. & Coates, H. (2008). Students' engagement in first-year university. *Assessment & Evaluation in Higher Education*, *33*, 5, 493–505. doi: 10.1080/02602930701698892.
Kuh, G. D. (2001). *The National Survey of Student Engagement: conceptual framework and overview of psychometric properties*. Bloomington, IN: Indiana University Center for Postsecondary Research & Planning.
Kuh, G. D. (2003). What we're learning about student engagement from NSSE: benchmarks for effective educational practices. *Change: The Magazine of Higher Learning*, *35*, 2, 24–32.
Löfström, E. & Nevgi, A. (2008). University teaching staffs' pedagogical awareness displayed through ICT-facilitated teaching. *Interactive Learning Environments*, *16*, 2, 101–116.
Lutz, M. E. & Culver, S. (2010). The National Survey of Student Engagement: a university-level analysis. *Tertiary Education and Management*, *16*, 1, 35–44. doi: 10.1080/13583881003629814.
Maddux, C. D. & Johnson, D. L. M. (2005). *Classroom integration of Type II uses of technology in education*. New York: The Haworth Press.
McAlpine, L. & Weston, C. (2000). Reflection: issues related to improving professors' teaching and students' learning. *Instructional Science*, *28*, 5, 363–385.
Mishra, P. & Koehler, M. J. (2006). Technological pedagogical content knowledge: a framework for teacher knowledge. [Feature]. *Teachers College Record*, *108*, 6, 1017–1054.
Nelson Laird, T. F. & Kuh, G. D. (2005). Student experiences with information technology and their relationship to other aspects of student engagement. *Research in Higher Education*, *46*, 2, 211–233. doi: 10.1007/s11162-004-1600-y.
NSSE (2008 Report). Promoting engagement for all students: the imperative to look within, 2008 results.
Pajares, M. F. (1992). Teachers' beliefs and educational research: cleaning up a messy construct. *Review of Educational Research*, *62*, 3, 307–332. doi: 10.3102/00346543062003307.
Pea, R. (1993). Practices of distributed intelligence and designs for education. In G. Salomon (Ed.), *Distributed cognitions: psychological and educational considerations* (pp. 47–87). Cambridge: Cambridge University.
Perkins, D. (1992). What constructivism demands of the learner. In T. Duffy & D. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 161–165). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
Pike, G. R. & Kuh, G. D. (2005). A typology of student engagement for american colleges and universities. [Article]. *Research in Higher Education*, *46*, 185–209. doi: 10.1007/s11162-004-1599-0.
Postareff, L. & Lindblom-Ylänne, S. (2008). Variation in teachers' descriptions of teaching: broadening the understanding of teaching in higher education. *Learning and Instruction*, *18*, 109–120. doi: 10.1016/j.learninstruc.2007.01.008.
Postareff, L., Lindblom-Ylänne, S. & Nevgi, A. (2007). The effect of pedagogical training on teaching in higher education. *Teaching and Teacher Education*, *23*, 5, 557–571. doi: 10.1016/j.tate.2006.11.013.
Pratt, D. (1992). Conceptions of teaching. *Adult Education Quarterly*, *42*, 4, 203–220.

Pundak, D. & Rozner, S. (2008). Empowering engineering college staff to adopt active learning methods. *Journal of Science Education and Technology*, *17*, 2, 152–163.
Richardson, J. C. & Newby, T. (2006). The role of students' cognitive engagement in online learning. *The American Journal of Distance Education*, *20*, 1, 23–37.
Salomon, G. & Almog, T. (1998). Educational psychology and technology: a matter of reciprocal relations. *The Teachers College Record*, *100*, 2, 222–241.
Salomon, G. & Globerson, T. (1987). Skill may not be enough: the role of mindfulness in learning and transfer. *International Journal of Educational Research*, *11*, 6, 623–637.
Salomon, G. & Perkins, D. (1998). Individual and social aspects of learning. *Review of Research in Education*, *23*, 1, 1–24. doi: 10.3102/0091732x023001001.
Samuelowicz, K. & Bain, J. (1992). Conceptions of teaching held by academic teachers. *Higher Education*, *24*, 1, 93–111.
Saroyan, A., Dagenais, J. & Zhou, Y. (2009). Graduate students' conceptions of university teaching and learning: formation for change. *Instructional Science*, *37*, 6, 579–600. doi: 10.1007/s11251-008-9071-8.
Schmid, R., Bernard, R., Borokhovski, E., Tamim, R., Abrami, P., Wade, C. *et al* (2009). Technology's effect on achievement in higher education: a stage I meta-analysis of classroom applications. *Journal of Computing in Higher Education*, *21*, 2, 95–109.
Sheard, J., Carbone, A. & Hurst, A. J. (2010). Student engagement in first year of an ICT degree: staff and student perceptions. *Computer Science Education*, *20*, 1, 1–16.
Sherman, T., Armistead, L., Fowler, F., Barksdale, M. & Reif, G. (1987). The quest for excellence in university teaching. *The Journal of Higher Education*, *58*, 1, 66–84.
Shields, M. A. (1995). *Work and technology in higher education: the social construction of academic computing*. Hillside, NJ: Lawrence Erlbaum Associates.
Stoney, S. & Oliver, R. (1999). Can higher order thinking and cognitive engagement be enhanced with multimedia. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning*, *1*(2). Retrieved from http://imej.wfu.edu/articles/1999/2/07/index.asp.
Sun, J. C. Y. & Rueda, R. (2012). Situational interest, computer self-efficacy and self-regulation: their impact on student engagement in distance education. *British Journal of Educational Technology*, *43*, 2, 191–204.
Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson.
Trigwell, K. & Prosser, M. (1996a). Changing approaches to teaching: a relational perspective. *Studies in Higher Education*, *21*, 3, 275–284.
Trigwell, K. & Prosser, M. (1996b). Congruence between intention and strategy in university science teachers' approaches to teaching. *Higher Education*, *32*, 1, 77–87.
Trigwell, K., Prosser, M. & Taylor, P. (1994). Qualitative differences in approaches to teaching first year university science. *Higher Education*, *27*, 1, 75–84.
Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: an analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research*, *72*, 2, 131–175. doi: 10.3102/00346543072002131.
Zhao, C. M. & Kuh, G. D. (2004). Adding value: learning communities and student engagement. *Research in Higher Education*, *45*, 2, 115–138.
Zwick, W. R. & Velicer, W. F. (1986). Comparison of five rules for determining the number of components to retain. *Psychological Bulletin*, *99*, 3, 432–442.