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Student perceived effectiveness of computer technology use in post-secondary classrooms ☆

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Abstract

This study investigated the relationship between the amount of computer technology used in post-secondary education courses, students' perceived effectiveness of technology use, and global course evaluations. Survey data were collected from 922 students in 51 courses at both the graduate and undergraduate levels. The survey consisted of 65 items broken down into seven areas, namely: (1) student characteristics, (2) learning experiences and course evaluations, (3) learning strategies, (4) instructional techniques, (5) computer use in course, (6) perceived effectiveness of computer use and (7) personal computer use. Contrary to expectations, no significant relationship was found between computer use and global course evaluations, nor was there a relationship between perceived effectiveness of computer use and global course evaluations. However, the results did yield a positive relationship between global course evaluations and the learning experiences that students engaged in. Students also indicated that they valued the use of computer technology for learning. Descriptive statistics on questions related to personal computer use show a strong favorable response to computer use and: facilitation of learning, value-added aspects such as usefulness to other classes and/or career, learning material in a more meaningful way, and working in groups with other students.

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1. Introduction

Whether computers can be of benefit to the learning process has been a topic of discussion since the 1950s. Computer technology has promised to revolutionize both teaching and learning in higher education. With the popularization of the Internet in the early 1990s, access to information, ease of communication, and the ability to become part of an electronic community, are among the multiple resources that have become widely available to students. Harris (1999) wrote, "I have reports from every type of educational institution of students demanding the implementation of email and Internet access . . ." (p. 244). We know that computers are being used and that students appear to welcome the technology but does this use and enthusiasm translate into perceptions of increased learning and increased course effectiveness?

Roblyer (2003) identifies two changes that have been brought about by the integration of technology. The first is an increase in the amount and type of technology resources that are available to instructors and learners. The second is the shift in learning strategies that the flexibility of computer technology affords. Traditional instruction generally involves an instructor-led, didactic approach to learning. The introduction of computers into the classroom has come with promises to change the passive learning approach by introducing interactive and dynamic capabilities into the classroom. This, it is argued, will provide a richer learning environment where the learner can be more actively involved in his or her own learning (Schank, 1993).

The North Central Regional Educational Laboratory (NCREL) organization (NCREL, 2002) believes that technology can promote higher order thinking skills such as thinking critically, analyzing, making inferences and solving problems when technology is used to situate learning in the context of challenging, complex and realistic problems. There is some evidence of this. Milliken and Barnes (2002) found that students perceived computer-enhanced lectures to be an improvement over traditional teaching methods and felt that the use of computer technology in class aided their comprehension of the subject matter.

1.1. Objectivist and constructivist views of teaching and learning

Philosophies of teaching and learning can be broken down into two broad categories: objectivist and constructivist. The objectivist position is that reality exists independently of the human mind and is not affected by an individual's particular belief system. Physical laws are constant, and are based on an objective and reliable set of facts, theories and principles. Perceived changes in the nature of reality are simply the evolution of our knowledge about the "truth" driven by the discovery of some previously unknown, but pre-existing, phenomena (Bates & Poole, 2003). The constructivist position is markedly different. The aim of constructivist learning is to provide learning environments that offer maximum learner control and learning opportunities that are meaningful to the learner, allowing the learner to be more active in their construction of mental representations of phenomena (Mayer, Moreno, Boire, & Vagge, 1999; McCombs, 2000). Learning is the result of

constructed meaning. What a student "brings" cognitively to the learning environment is very important to the constructivists as it will determine what and how knowledge is constructed by the learner (Ausubel, 1963; Winn, 2003). Thus, it is more important to understand the subjective reality of the learner than the objective reality of external rules or events.

Traditional post-secondary classrooms have often been instructor-led and static in the way that material is made available to learners. University faculty have typically relied upon lectures and readings from textbooks that culminate with a final exam to evaluate achievement. With this approach, the student is seen as a passive recipient of information and the instructor is viewed as the primary information presenter (Laurillard, 2002). Critics claim this promotes a reliance on rote learning in an attempt to memorize important facts that may be used on the exam (McCombs, 2000).

Constructivist models shift the focus from student as passive recipient of information to active constructor of knowledge (Good & Brophy, 1995). The ideas of Dewey, Piaget, Bruner and Vygotsky are linked to constructivist approaches though, historically, constructivism can be traced as far back as Plato and Socrates. A basic tenet of constructivism is that any idea, developed and discovered by the learner, is valid, and that multiple representations and interpretations of knowledge are encouraged. Learning is a social and active process, where the focus shifts from teacher-directed to student-directed learning.

Social negotiation is important in constructivism (Vygotsky, 1962). Learning occurs and is demonstrated in social contexts. Effective social situations encourage collaboration and tolerance of other viewpoints. Constructivist practitioners suggest that social negotiation legitimizes concepts constructed by the learner. That is, not every new idea constructed by the learner is correct, but the learning community will inform the learner of his/her misconceptions and help him/her to adjust. The instructor serves as a guide for the learner by presenting learning opportunities and directing the learner toward learning resources (Lambert & McCombs, 1998). The instructor must consider student perceptions and determine whether personal learning goals and interpersonal needs are being met. From the learner's perspective instruction should be meaningful and relevant and provide appropriate learning challenges. Tasks should support critical thinking and flexibility with respect to learning opportunities and individual differences. Learner control should be emphasized and there should be opportunities for social interaction and support for individual interests (Lambert & McCombs, 1998). In these ways, meaning is constructed through the assimilation and accommodation of information, ideas originally presented by Piaget (1955). The belief is that computer technology has the potential to transform a passive learning environment into one that is more active and under the control of the learner. However, this is largely dependent on how the computer technology is used. Learning with technology should be more than "post-a-lecture" or "host-a-discussion" (Weigel, 2001, p. 2). These uses do not differ from non-technology use other than they are electronic. In contrast, through increased flexibility and access to materials and their peers and the instructor, learners have increased opportunities to manipulate and reflect upon material resulting in the potential for increased integration of new learning and a deeper understanding.

1.1.1. Learning outcomes

From a constructivist perspective, computer technology has the potential to support diverse needs and capacities within the student population and to allow students greater control over their learning (McCombs, 2000), as well as the potential for deeper processing of information, especially if the computer is used to replicate authentic activities. But having computer tools available

is, by itself, not enough. The tools have to be paired together with appropriate pedagogy to be effective (Laurillard, 2002).

1.1.2. Active learning

In an instructor-led, lecture-based classroom, students frequently do not have the opportunity to ask questions or engage in discussion that would allow them to reflect on and refine their understanding of the material being presented (Laurillard, 2002). Under such circumstances, technology is often used only as an extension of the blackboard (Yazon, Mayer-Smith, & Redfield, 2002), or for drill-and-practice and tutorials (Roblyer, 2003). Supporters of technology implementation have argued that computer technology can be effective in changing the traditional teacher-centered classroom to a more constructivist student-centered classroom (Jonassen & Reeves, 1996; Kent & McNergney, 1999), through the introduction of interactive and dynamic computer applications (Shuell & Farber, 2001).

Does the use of computer technology in a course translate into increases in perceived course effectiveness? Factors that might be important in predicting computer technology effectiveness include student characteristics, learning experiences, learning strategies, instructional techniques, actual computer use in the course and personal computer use (Laurillard, 2002; Shuell & Farber, 2001). In order for learning to be effective the learner must actively use the tools available in order to build a deeper understanding of the material to be learned (Brown, Collins, & Duguid, 1989). Simply presenting information to students does not guarantee that learning will take place.

1.1.3. Learning experiences

Within the constructivist, learner-centered framework, positive learning experiences would include feelings of effective interactions with the instructor and other students where the learner felt that he or she was in control of their own learning. Positive learning experiences are facilitated through increased opportunities for active participation and increased access to learning resources (Lambert & McCombs, 1998).

1.1.4. Learning strategies

Students need to develop effective learning strategies in order to promote life-long learning (Zimmerman, 1994). Learners use a variety of strategies to learn material. Bloom (1956) putforth a taxonomy of six categories in the cognitive domain to describe learning. These are Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. The category "knowledge" relies on recall of information and promotes the use of rehearsal as a learning strategy. "Comprehension" focuses on the elaboration and understanding of material. "Application" strategies focus on use, demonstration or organizational strategies. "Analysis" strategies focus on explanation and comparison. "Synthesis" requires the learner to create new ideas, and "course evaluation" focuses on critical evaluation of material (Bloom, 1956). Rehearsal techniques tend to be the least effective strategy for deep processing of information. More effective strategies include the use of synthesis and/or evaluation techniques where the learner can relate ideas to previous knowledge, critically evaluate material, and be more active and aware of their learning (Entwistle, 1994). These effective strategies may be enhanced when technology is well integrated into courses.

In our survey, we explored the learning strategies in use and the extent to which these techniques correlated with technology use.

1.1.5. Instructional techniques

Laurillard (2002) believes that the current instructor-led system must change. Rather than a focus on imparting knowledge instructors should focus on creating learning environments that make learning possible. Instructional techniques might include the type of learning materials that are made available to the learner, the type of discourse that occurs inside and outside the class, and collaborative versus individual assignments. It is important for the learner to be able to set their own learning goals (Zimmerman, 1994). "It is the teacher's responsibility to create the conditions in which understanding is possible, and the student's responsibility to take advantage of that" (Laurillard, 2002, p. 1).

1.1.6. Computer use in courses

A recent study by Shuell and Farber (2001) raised the question of how student perceptions of technology implementation affect learning. Their results indicated that students view technology as beneficial in facilitating learning, as well as increasing motivation to learn. They also found, however, that when technology was considered static, such as when used in simple presentations, it was not perceived as valuable. In contrast, technology that was considered dynamic, such as when used for participating in online discussions, there was a perception of its value.

1.1.7. Personal computer use

Students are generally very positive about the use of technology in their classes when: its use is perceived as improving student learning; computer skills are perceived as beneficial to future careers (Shuell & Farber, 2001); or generally its use has a value-added component (Harris, 1999). We also expect that if the use of computer technology is seen as helping students learn the material, be more efficient in learning tasks, or serve future needs, the perceived effectiveness of that technology should increase.

1.1.8. The current investigation

The studies conducted to date outline the potential benefits of integrating computer technology into the learning environment. As a result, we expect computer technology use to increase student perceived effectiveness of learning and instruction particularly when computer technology use promotes active learning and reflection. Therefore, the purpose of this study was twofold. The first part of the study was concerned with the question: How do students describe their use of computer technology for learning? Specifically, do students believe that computers facilitate their learning? Also, in what way and to what degree are instructors in this study using computer technologies? The second part of the study investigated the following questions:

(1) Is the quantity and quality of computer use related to the learning experiences that students had in the course and were these learning experiences related to overall effectiveness?
(2) Is the quantity and quality of computer use related to the learning strategies that were used in the course and are they related to overall effectiveness?
(3) Is the quantity and quality of computer use related to instructional techniques that were used in the course and are they related to overall effectiveness?

(4) Is the quantity and quality of computer use related to personal computer use and is this related to overall effectiveness?

Responses to these questions will assist in gaining a better understanding of how computer technology use is perceived by students and whether or not its use is predictive of global course evaluations as well as a better understanding of what students consider effective technology use. Additionally, these data represent student and faculty perceptions on how technology is being used to transform classroom protocol from passive to active learning.

2. Method

A faculty list was received from the Office of Academic Relations of a large, urban North American university. Letters and consent forms were sent out to approximately 700 full-time and part-time instructors using the internal mail system. Data collection was conducted by visiting the classrooms, distributing and collecting the survey, and answering any questions that the students or instructors posed. Data collection occurred in March and April 2002.

2.1. Questionnaire construction

The pedagogy/technology (PedTech) survey was designed to examine what, if any, effect the use of computer technology has on student perceived effectiveness of a course. Relevant studies (e.g., Shuell & Farber, 2001) identifying factors related to computer technology use in educational settings helped create an initial pool of items. The final survey instrument consisted of 65 items for the student survey (see Appendix A) and 62 items for the instructor survey (See Appendix B.1). The student survey was modified for instructor participants by asking different demographic questions, eliminating global evaluations and adding a question concerning perceived computer efficiency. The student survey was divided into eight sections.

Section I: Student Characteristics: Students were asked to indicate the Faculty that they were enrolled in (e.g., Arts and Sciences), student status, expected grade for the course, and gender.

Section II: Learning Experiences: Students were asked to rate seven statements related to their learning experiences in the course.

Section III: Learning Strategies: Students were asked to indicate the learning strategies that they used within the class (e.g., rehearsal, elaboration, organizational strategies, analysis, synthesis or evaluation).

Section IV: Instructional Techniques: Students were asked to evaluate the overall effectiveness of the instructional techniques used in the class. Options range from instructor led lectures to experiential learning and/or field studies.

Section V: Overall Perceived Effectiveness: Students were asked to evaluate the overall effectiveness of the course in relation to instructor effectiveness, amount learned, increased interest in course content, etc.

Section VI: Computer Use in Course: Students were provided with statements related to the manner of technology use (e.g., instructional supplement, expansive uses, communication). The

list also included a global statement regarding amount of perceived overall computer technology use by the instructor.

Section VII: Perceived Effectiveness of Computer Use: Students were asked to indicate how *effectively* computer technology was used in the course. Effectiveness ratings were reported for each of the uses outlined in Section VI. The section concluded with a global statement regarding amount of perceived overall effective use of computer technology use by the instructor.

Section VIII: Personal Computer Use: Students were asked to indicate how they personally used computer technology. The majority of the questions were evaluative in nature (e.g., computers make my job as a student a lot easier).

3. Sample

3.1. Sample and setting descriptions

The initial sample for this study consisted of 51 faculty and 1231 students in 61 classes. From the total sample of 1231 student responses, 54 were held aside from further analysis due to noticeably unreliable responding, such as respondents leaving out more than 10% of any one section or if the response pattern was suspect. As well, student responses in classes where the instructor did not fill out a survey were eliminated from the analysis. Among the 922 remaining respondents, missing data on survey items were replaced (Tabachnik & Fidel, 1996). For Sections I, IV, VI, VI and VII, missing data were replaced with the variable or group response mean for the particular class. For Sections II and III, missing responses were replaced with the group mean of significantly correlated variables for this section. For Sections V and VIII, missing responses were replaced with the respondent's mean score for this section.

Forty-four percent of the student sample was male and 56% was female. Class sizes ranged from 5 to 46 students ($M = 33.5$, SD = 18.49). Instructors generally reported being proficient with computer technologies; 5% indicated that they were at the advanced level of proficiency having "acquired the ability to competently use a broad spectrum of computer technologies."

4. Results

4.1. Composite learning experiences and global evaluation variables

To investigate the relationship between amount of computer technology use and student perceptions of course effectiveness, a composite for course evaluation was created using Items 27–30. Significant positive correlations between items provided justification for creating a global "course evaluation" variable.

4.2. In what way, and to what degree are instructors in this study using computer technologies?

Instructors generally reported using computer technologies for instructional purposes. Eleven percent of the professors ($n = 5$) reported that they "never" use computer technology in the course

in question. Twenty-eight percent ($n = 13$) indicated that computers were integrated into the course "very often." Frequency of computer use was *not* significantly related to Faculty in which the instructor taught, current teaching status, teaching load or years of teaching completed. Instructors and students were asked to report how frequently computers were used in the course for a number of instructional purposes (see Items 28–38 Appendix B.1 and Items 31–41 Appendix B.1). Cronbach's alpha for instructor's responses to Items 28–38 yielded a high internal consistency of 0.74. Cronbach's alpha for student responses was 0.89.

Students and instructors generally perceived technology to be used for the same instructional purposes. Both students and instructors indicated that computer technologies were used more frequently for communicative (e.g., e-mail), presentation (e.g., PowerPoint) and accessibility (e.g., class website) purposes. However, whereas 59% of students perceived that computers were used for "communicative" purposes, "sometime," "often" or "very often," 87% of instructors felt computers were used for communicative purposes "sometimes," "often" or "very often."

4.3. What evidence is there that perceived instructor effectiveness in using computers impacts on students' overall student perceived effectiveness of the course?

We predicted that students in classes where the perceived effective use of computer technology by the instructor was high would result in higher beliefs that, overall, the course had been a good course. For those courses where the majority (>50%) of individual students responded "not applicable" to Item 54 (i.e., how effective was computer technology used by your instructor in this course) responses were flagged and not included in the correlation analysis. Correlations were then conducted using the unweighted composite variable "course evaluation" and Item 54. No significant relationship was found between perceived effectiveness of computer use by the instructor and global course evaluations.

4.4. What evidence is there that the frequency of instructors' computer technology use has a positive impact on students' overall course evaluation?

We predicted that students in classes with high levels of computer technology use were more likely to agree that overall the course had been a good course than students in classes with a lower level of computer technology use. Correlations were computed on students' responses to Item 42 (i.e., how often computer technology was used by the instructor), and the composite "course evaluation" variable. The results indicated no significant relationship between the amount of computer use by the instructor and students perceptions of course effectiveness. The type of computer technology used by the instructor did not appear to influence how students rate the overall effectiveness of the course. However, there was a positive relationship between the amount that students indicated instructors used technology as part of the course and student perceived effectiveness of instructor computer use ($r = 0.813$, $p = 0.000$). The more instructors used computer technology as part of the course the more students believed the use was effective.

A one-way analysis of variance was used to examine further the relationship between amount of computer use and student evaluations. The ANOVA revealed no significant difference between students in classes with no computer technology use ($M = 3.53$, $SD = 0.589$), little use ($M = 3.71$, $SD = 0.526$) or a lot of computer technology use ($M = 0.374$, $SD = 0.550$).

Table 1
Matrix of intercorrelations between all pairs of variables relationship between amount of computer technology use, perceived effectiveness of computer technology use and overall course evaluations

Variable	Amount	Effectiveness	Evaluation
Amount	–		
Effectiveness	0.813	–	
Evaluation	0.005	0.197	–

* $p < 0.05$.

Table 2
Regression coefficients and their significance in predicting course evaluation

Unstandardized coefficients			Standardized coefficients		
Model	*B*	Standard error	Beta	*t*	Significance
Constant	2.482	0.684		3.630	0.001
Amount	−0.229	0.144	−0.457	−1.595	0.121
Effective	0.546	0.275	0.568	1.983	0.056

* Dependent variable: overall course evaluation.

Multiple regression analysis was used to explore the relationship between amount of computer technology use, perceived effectiveness of computer technology use and overall course evaluations. All of the variables are continuous and the correlations are reported in Table 1. Correlations between the outcome variable evaluation (Item 27) and the two predictor variables, "amount" (Item 42) and "effectiveness" (Item 54) are 0.005 and 0.197, respectively. These relationships are not statistically significant.

Neither of the two predictors, amount of computer technology used in the course by the instructor and student perceived effectiveness of computer technology used in the course, is statistically related to perceived course effectiveness. However, there is a positive relationship between the amount of computer technology used in the course by the instructor and student perceived effectiveness of computer technology use. See Table 2.

4.5. To what extent do students' learning experiences relate to overall course evaluation?

The results revealed that student learning experiences were greater predictors of course evaluation than was the use of technology. Correlations between the unweighted composite variable "course evaluation" yielded significant positive correlations for all learning experiences variables except Item 6 (i.e., I had effective interactions with other students). The results of correlation analysis are reported in Table 3. The most highly correlated item was #10 (i.e., I developed knowledge of basic concepts and facts) ($r = 0.673$, $p < 0.05$).

4.6. What is the relationship between students' personal experience and attitudes towards computers and their overall ratings of the course?

Analyses were conducted to determine the nature of the relationship between students' personal computer use and course evaluations. These analyses revealed that 75% of the students surveyed

Table 3
Relationship between student learning experiences and global course evaluations

Item**	Survey item	"Course evaluation"
5	Effective interactions with instructor	0.645*
6	Effective interactions with other students	0.265
7	Control of my learning	0.527*
8	Actively participated	0.294*
9	Took advantage of learning opportunities	0.452*
10	Developed knowledge of basic concepts and facts	0.673*
11	Learned to think critically about subject	0.525*

* $p < .05$.
** Item numbers refer to student survey, see Appendix A.

believed that computers make their job as a student a lot easier ($M = 4.20$, $SD = 0.968$) and 83% of the students generally agreed that computer technology was useful for other classes and/or their career ($M = 4.41$, $SD = 0.833$). When asked if they enjoy working with a computer 70% of the students agreed or strongly agreed ($M = 4.03$, $SD = 1.01$). When asked if computers help them learn the material in a meaningful way, 54% of the students agreed or strongly agreed ($M = 3.59$, $SD = 1.07$). Sixty-two percent of the students believed that computers make it easier to work in groups with other students ($M = 3.69$, $SD = 1.19$). When asked if their learning experience in the course was facilitated with the use of a computer, 47% of the students surveyed agreed or strongly agreed ($M = 3.33$, $SD = 1.26$). Sixty-six percent of the students believed that the use of computers improved the quality of their work ($M = 3.76$, $SD = 1.09$).

To investigate the relationship between student personal computer use and global evaluations, we correlated the unweighted composite "course evaluation" with Items 55–65. For those courses where the majority (>50%) of individual students responded "not applicable" to any of the items, responses were flagged and not included in the correlation analysis. The correlation revealed only one significant result. Item 61 (i.e., my learning experience in this course was facilitated with the use of a computer) showed a modest but significant positive relationship with the composite variable "course evaluation" ($r = 0.328$, $p = 0.036$), indicating that when students believed that personal computer use in connection with the course facilitated their learning of the material, ratings on global course evaluations increased.

4.7. Further analyses

Further analyses were conducted for exploratory purposes.

4.8. Examining the variables control, amount and usefulness with overall course evaluation as the criterion

The variables in this analysis were measured as follows: (a) *Control* refers to the class mean response to the question "In this course I felt I was in control of my learning." (b) *Amount* refers to

Table 4
Matrix of intercorrelations between all pairs of variables

Variable	Control	Amount	Useful	Evaluation
Control	–			
Amount	−0.042	–		
Useful	0.015	0.304*	–	
Evaluation	0.590	−0.001	0.187	–

* $p < 0.05$.

the amount of student-reported computer technology use by the instructor in the course. and (c) *Perceived Usefulness* refers to the degree to which students agreed with the statement, "Computer technology is useful for other class and/or my career." According to Table 4, none of the three variables is statistically related to the belief that overall, this has been a good course. However, there is a positive relationship between the amount of computer technology used in the course and students who believe that computers are useful beyond the course.

5. Discussion

Although the majority of university classrooms are still dominated by traditional teaching methods such as lectures and discussions, teaching and learning is moving away from the idea that the student is a passive recipient of information and moving toward the idea that the learning process is active and learner-centered (Yazon et al., 2002). This change in emphasis is concomitant with the steady increase in the availability and use of computer technologies. Still, we often see technology poorly used. Harris (1999) says that most technology used in higher education is simply a recreation of notes or what he calls "reproducing the old curriculum in a new medium" (p. 248). A common criticism of computer integration is that computers are most commonly used for drill-and-practice exercises that typically do not promote deep and meaningful learning (Schacter & Fagnago, 1999). Instructors often do not consider why they are using technology in their classes. According to Grasha and Yangarber-Hicks (2000), many instructors appear to use technology simply to "try it out."

It is clear that the potential to improve teaching and learning with computer technology is not without conditions. Computer technology must be used appropriately in order to be effective (McCombs, 2000). Ehrmann (1995) believes that technology will improve teaching and learning and that instruction will be revolutionized with the use of computers but part of the problem may be how and what students are being taught. In our survey, we explored the instructional techniques in use and the extent to which these techniques correlated with technology use.

The present study was designed to gain a better understanding of the relationship between the amount of computer technology use by both the learner and the instructor and whether this use affected the perceived effectiveness of the course in which the learner was enrolled. The premise was that computer technology is related to and may enhance learner control and active learning, and that increased use would result in increases in perceived effectiveness of the course. As predicted, there was a significant relationship between global course evaluations and the learning

experiences that student engaged in. Students who felt that they were in control of their learning, actively participated, and took advantages of learning opportunities and resources, rated perceived course effectiveness higher than students who did not have these learning experiences. This result is consistent with outcomes predicted for the learner-centered approaches to instruction (Lambert & McCombs, 1998; Laurillard, 2002; Ward & Newlands, 1998).

Contrary to expectation, however, there was no significant relationship between computer use and global course evaluations or between perceive effectiveness of that computer use and global course evaluations. This result was somewhat surprising given the benefits that have been outlined in favor of computer technology use. It is clear from our results that students value the use of computer technology for learning. Descriptive results on questions related to personal computer use show a strong favorable response to (a) computer use and facilitation of learning, and (b) value-added aspects of technology including usefulness to other classes and/or career, learning material in a more meaningful way, and working in groups with other students.

One possible explanation for the non-significant relationship is that students may view technology use as commonplace in their learning environment and a natural tool to use. Ease of access to computers may further encourage this perception. Computer use may be so natural for some students that it has become transparent. As an example, in a casual conversation with some of the students following the study it became evident that, in some cases, students who used a word processor to write a term paper did not consider it "using computer technology."

A second explanation may be that effective technology use may be expected by the student rather than seen as something that will promote learning. Course websites where students can retrieve material are becoming more and more common. Also, it is not uncommon for textbook publishers to maintain companion websites for their textbooks. As course satisfaction is related to whether or not students believe that they have learned, it is possible that the technology used was perceived as a means to deliver the material and not as a means to promote learning.

A third possible explanation focuses on the nature of technology use related to perceived effectiveness. For example, perhaps few instructors were able to successfully use technology as a transformative, student-centered tool for learning. Though drill-and-practice and other directed uses for the computer have merit, allowing students to develop rapid recall of information which can help to create a solid foundation for future learning (Roblyer, 2003), these uses tend to offer limited opportunity for reflection and refinement (Laurillard, 2002). According to learner-centered researchers such as Laurillard (2002) and McCombs (2000), among others, the more effective uses of computer technology are those that place the locus of control in the hands of the learner, allowing for greater flexibility with respect to learner styles and access to information, collaboration, increased communication, and greater opportunity for feedback. Computer technology use that does not support a learner-centered approach may be perceived as less effective to the learner.

Finally, there are potential limitations to the current investigation. This study focused primarily on the amount of computer technology use in a course and how this relates to student perceived effectiveness of that course. Though the survey asked both the students and the instructors if they believed that the use of computer technology was effective the survey did not address precisely the nature of computer technology uses that relate to perceived effectiveness. Future investigations should explore the *process* of technology integration in classes as a means of better understanding the products of technology integration. Emphasis should be placed on how computer technology

may allow the educational environment to be more learner-centered (Laurillard, 2002). As well, the *context* in which computer technology is used may be the key to its perceived effectiveness and consequently the perceived effectiveness of the course. The emphasis should not be on the quantity of technology used or even on the type of technology being used but rather on how the technology is being used (Laurillard, 2002). This distinction may separate computer technology that is an enabling tool from technology that is a transformative tool (Bransford, Brown, & Cocking, 2000).

Further to this, an examination of instructional and learning strategies in connection with computer technology use should be carefully reviewed. According to Laurillard (2002), before we can begin to assess the impact of technology on education we have to focus on how teachers teach and how students learn. This is similar to Clark (1994) who pointed out that benefits attributed to technology can be explained by the teaching method used, and Thornburg (1999) who reminded us that how you use technology is far more important than if you use technology. Future research should focus on the importance of the context of computer-technology use, learner-centeredness (as evidenced by instructional/learning strategies) and perceived effectiveness of the course. The authors are conducting such an investigation to follow-up on and extend the present study.

5.1. Implications for practice

This study found that students generally have positive perceptions of the use and value of technology for learning. By itself, this is sufficient incentive for college administrators and faculty to continue to emphasize the integration of computers into most facets of postsecondary education. At the same time, there did not appear to be substantial evidence that students perceived that faculty were using technology as a transformative tool for learning. Faculty did not integrate computers into their courses so that the tool was used by students to engage in higher order thinking. There is work to be done if the promise of technology for learning is to be realized. At the same time, we failed to find evidence of a strong relationship between the quantity of technology use and perceived course effectiveness. To us, this suggests that more is not better. Instead, different may be better.

The trend toward increased computer use in the classroom increases pressure on faculty and students to become proficient with that technology. But as Kozma (1994) reminds us, we cannot assume that because computers are being used that they will be effectively used. The computer technology must support the pedagogy in place for learning (Laurillard, 2002; Roblyer, 2003). Moreover, how instructors use the technology will have an impact on how students use it. For example, Parr (1999) found that the way students use technology depends largely on how they perceive the instructor intended the technology be used. For this reason, Parr recommends that the instructor focus learning technologies on the context of instruction and emphasize deep learning approaches. However, instructors rarely have formal training in how to use computers for teaching (Bates & Poole, 2003). Bates and Poole (2003) recommend that for successful computer technology integration there should be institutional support for course development that provides support for students and faculty to use technology wisely and well. Unfortunately, current practices in most institutions is for instructors to be left to themselves to decide and design how best to use technology in their classes.

Bates and Poole (2003) recommend key elements to successful teaching with technology. The first are quality course content and course and program planning. A poorly structured course will not improve because of technology. The instructional design of the course should incorporate the strengths and benefits that computer technologies provide. Second, instructors and learners require support and guidance for media production and utilization.

Third, computer technology use should improve the quality of teaching and learning by increasing flexibility for both instructors and learners. The result of this would be increased opportunities for learners to achieve their individual learning goals. However, in order for this to be realized, technical and educational support is a must.

6. Conclusion

Technology integration is a major focus on many campuses and resources for computer technology comprise an increasingly significant proportion of institutional budgets. However, research on the effects on learning are variable and inconclusive (Jonassen & Reeves, 1996; Burns & Ungerleider, 2003). We need better controlled studies of technology integration, with good measures of achievement, and ways to carefully describe the methods of technology integration to study its products/outcomes. At the same time, there is value in exploring aspects of technology integration and the impact of these aspects on student perceptions of learning.

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Appendix A. Student perceived effectiveness of computer technology use student questionnaire

We are conducting research to examine what, if any, effect the use of computer technology has on student perceived effectiveness of a class. To accomplish this we will be surveying both faculty and students in classes that use computer technology and those that do not. The information we gather from this study will help to develop a further understanding of what role technology plays in student perceived effectiveness of a course as well as how students prefer to learn.

In order to obtain comprehensive data we are interested in responses from both classes that use technology and those that do not. Please read the instructions carefully and answer the questions honestly.

All individual responses will be kept strictly confidential and will only be seen by the research team. You will at no time be identified in any way. Your responses will be included on aggregate summaries. Participation in this research project is voluntary and you are free to discontinue at

any time. However, your experience and options are crucial to helping understand what role technology plays in student perceived class effectiveness. We would greatly appreciate your taking the time to complete our questionnaire.

The survey should take approximately 15 minutes to complete. Please hand your completed survey to the facilitator when you are done.

A.1. Conditions of participation

- I understand that by completing the survey I agree to be a part of the research.
- I understand that my responses will be reviewed by the researchers of this study.
- I understand that I am free to withdraw from the project at any time and that my data will be excluded from the analysis.
- I understand that my involvement in this project is completely voluntary.
- I understand that my participation will remain confidential.
- I understand that the results of this study may be published.

Thank you very much for taking the time to fill out the survey.

INSTRUCTIONS

Please mark **ALL** your answers on the accompanying Answer Sheet by circling the most appropriate response. All of the questions on this survey apply to you, your instructor and this course **ONLY**.

After you have completed the survey, please return both the survey and the answer sheet to your facilitator.

A.2. Section I: Student characteristics

1. Which faculty are you currently enrolled in?
   - A. Arts & Science
   - B. John Molson School of Business
   - C. Engineering/Computer Science
   - D. Fine Arts
   - E. Other (i.e., individualized programme)
2. Please indicate your student status?
   - A. Full-time
   - B. Part-time
   - C. Independent
   - D. Continuing education
   - E. Other (please specify)
3. Please indicate your expected grade for this course.
   - A. A (A−, A or A+)
   - B. (B−, B or B+)
   - C. (C−, C or C+)
   - D. D (D−, D or D+)
   - E. F
4. Please indicate your gender:
   - A. Female
   - B. Male

A.3. Section II: Learning experiences

Using the scale provided, please rate the extent to which you agree or disagree with the following statements.

A	B	C	D	E
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

In this course . . .

5. I had effective interactions with the instructor.
6. I had effective interactions with other students.
7. I felt that I was in control of my learning.
8. I actively participated.
9. I took advantage of learning opportunities and resources.
10. I developed knowledge of basic concepts and facts.
11. I learned to think critically about this subject.

A.4. Section III: Learning strategies

Using the scale provided, please indicate how often you used the following learning strategies while taking ***this*** course.

A	B	C	D	E
Never	Seldom	Sometimes	Often	Very Often

When studying for this class

12. I used rehearsal strategies such as reading my notes over and over.
13. I used elaboration strategies such as summarizing the material and relating it to material I already know.
14. I used organizational strategies such as creating outlines and taking note of the most important ideas.
15. I used analysis strategies such as comparing and contrasting ideas.
16. I used synthesis strategies such as examining the material and forming new ideas, theories or hypotheses.
17. I used evaluation strategies such as assessing, evaluating, and/or critiquing the material.

A.5. Section IV: Instructional techniques

Using the scale provided, please indicate how often the following instructional techniques were used in this course.

A	B	C	D	E
Never	Seldom	Sometimes	Often	Very Often

18. Instructor led lectures.
19. Textbooks or other written material.
20. Class discussions.
21. Independent projects and/or independent assignments.
22. Group projects and/or group assignments.
23. Computer based instruction.
24. Portfolios.
25. Student-developed activities.
26. Experiential learning and/or field studies.

A.6. Section V: Overall perceived effectiveness

Using the scale provided, please rate the extent to which you agree or disagree with the following statements.

A	B	C	D	E
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

27. Overall, this course has been a good course.
28. Overall, the professor is an effective teacher.
29. Overall, I learned a lot in this course.
30. My interest in this subject area has increased as a result of taking this course.

A.7. Section VI: Computer use in course

Using the scale provided, please indicate how ***often*** the following computer applications were used by the instructor as part of this course.

A	B	C	D	E
Never	Seldom	Sometimes	Often	Very Often

31. Instructional Supplements such as drill and practice exercises or tutorials.
32. Communication such as email, mailing lists, conferencing, ICQ or FirstClass.
33. Organizational applications such as databases and/or spreadsheets.
34. Analytical/Programming applications such as statistics, charting, graphing, drafting or robotics.
35. Expansive uses such as simulations or experiments.
36. Creative uses such as desktop publishing, digital videos, digital cameras, scanners or graphics.
37. Expressive uses such as word processing or on-line journals.
38. Evaluative uses such as electronic portfolios.
39. Informative uses such as Internet, CD-ROM or DVD.
40. Presentation applications such as PowerPoint and/or LCD projector.
41. Access applications such as a class website or class folder.
42. Overall, how often was computer technology used by your instructor in this course?

Please use *Not Applicable* if computer technology was not used for this course.

A.8. Section VII: Perceived effectiveness of computer use

Using the scale provided, please indicate how ***effective*** the following computer applications were used by the instructor as part of this course.

A	B	C	D	E
Very Ineffective	Ineffective	Neutral	Effective	Very Effective

NA
Not Applicable

Please use *Not Applicable* if computer technology was not used for this course.

43. Instructional Supplements such as drill and practice exercises or tutorials.
44. Communication such as email, mailing lists, conferencing, ICQ or FirstClass.
45. Organizational applications such as databases and/or spreadsheets.
46. Analytical/Programming applications such as statistics, charting, graphing, drafting or robotics.
47. Expansive uses such as simulations or experiments.
48. Creative uses such as desktop publishing, digital videos, digital cameras, scanners or graphics.
49. Expressive uses such as word processing or on-line journals.
50. Evaluative uses such as electronic portfolios.
51. Informative uses such as Internet, CD-ROM or DVD.
52. Presentation applications such as PowerPoint and/or LCD projector.
53. Access applications such as a class website or class folder.
54. Overall, how effectively was computer technology used ***by your instructor*** in this course?

A.9. Section VIII: Personal computer use

Using the scale provided, please rate the extent to which you agree or disagree with the following statements.

A	B	C	D	E
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
NA				
Not Applicable				

Please use *Not Applicable* if computer technology was not used for this course.

55. Computers make my job as a student a lot easier.
56. Computer technology is useful for other classes and/or my career.
57. I enjoy working with a computer.
58. Computers help me to learn the material in a meaningful way.
59. Computers make it easier to work in groups with other students.
60. I can always find a computer to work on when I need one.
61. My learning experience in this course was facilitated with the use of a computer.
62. I used a computer for this course because I had to not because I wanted to.
63. The use of computers improved the quality of my work.
64. The computer technology used in this course did not work the way that it was supposed to.
65. Using computer technology was necessary for me to do well in this course.

Additional comments

If there are any questions, comments or suggestions that you would like to add to improve this survey please add them on the sheet provided. We would love to hear from you! All comments welcome.

Thank you for taking the time to fill out our survey

INSTRUCTIONS

Please mark **ALL** your answers on the accompanying Answer Sheet by circling the most appropriate response. All of the questions on this survey apply to you and this course **ONLY**.

After you have completed the survey, please return both the survey and the answer sheet to your facilitator.

Appendix B

B.1. Section I: Instructor characteristics

1. Which faculty do you currently teach in?
   - A. Arts & Science
   - B. John Molson School of Business
   - C. Engineering/Computer Science
   - D. Fine Arts
   - E. Other
2. What is your current title?
   - A. Lecturer
   - B. Assistant Professor
   - C. Associate Professor
   - D. Full Professor
   - E. Other
3. What best describes your teaching load?
   - A. Full-time
   - B. Part-time
   - C. Sessional
   - D. Retired
   - E. Other
4. Years of teaching completed (If this is your first year, indicate '0'. If last year was your first, indicate '1', and so on.)

B.2. Section II: Perceived student learning experiences

Using the scale provided, please rate the extent to which you agree or disagree with the following statements.

A	B	C	D	E
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

In this course I felt that the students ...

5. had effective interactions with the instructor.
6. had effective interactions with other students.
7. were in control of their learning.
8. actively participated.
9. took advantage of learning opportunities and resources.
10. developed knowledge of basic concepts and facts.
11. learned to think critically about this subject.

B.3. Section III: Teaching strategies

A	B	C	D	E
Never	Seldom	Sometimes	Often	Very Often

When studying for this course I encouraged the students to use ...

12. rehearsal strategies such as reading my notes over and over.
13. elaboration strategies such as summarizing the material and relating it to material I already know.
14. organizational strategies such as creating outlines and taking note of the most important ideas.
15. analysis strategies such as comparing and contrasting ideas.
16. synthesis strategies such as examining the material and forming new ideas, theories or hypotheses.
17. evaluation strategies such as assessing, evaluating, and/or critiquing the material.

B.4. Section IV: Instructional techniques

A	B	C	D	E
Never	Seldom	Sometimes	Often	Very Often

18. Instructor led lectures.
19. Textbooks or other written material.
20. Class discussions.
21. Independent projects and/or independent assignments.
22. Group projects and/or group assignments.
23. Computer based instruction.
24. Portfolios.
25. Student-developed activities.
26. Experiential learning and/or field studies.

B.5. Section V: Perceived computer proficiency level

27. Please read the following descriptions of the proficiency levels a user has in relation to computer technologies. Determine the level that best describes you and circle the corresponding letter on your answer sheet.

A. Unfamiliar
I have no experience with computer technologies.
B. Beginner
I am able to perform basic functions in a limited number of computer applications.
C. Average
I demonstrate a general competency in a number of computer applications.
D. Advanced
I have acquired the ability to competently use a broad spectrum of computer technologies.
E. Expert
I am extremely proficient in using a wide variety of computer technologies.

B.6. Section VI: Computer use in course

Using the scale provided, please indicate how ***often*** you used the following computer applications as part of this course.

A	B	C	D	E
Never	Seldom	Sometimes	Often	Very Often

28. Instructional Supplements such as drill and practice exercises or tutorials.
29. Communication such as email, mailing lists, conferencing, ICQ or FirstClass.
30. Organizational applications such as databases and/or spreadsheets.
31. Analytical/Programming applications such as statistics, charting, graphing, drafting or robotics.
32. Expansive uses such as simulations or experiments.
33. Creative uses such as desktop publishing, digital videos, digital cameras, scanners or graphics.
34. Expressive uses such as word processing or on-line journals.
35. Evaluative uses such as electronic portfolios.
36. Informative uses such as Internet, CD-ROM or DVD.
37. Presentation applications such as PowerPoint and/or LCD projector.
38. Access applications such as a class website or class folder.
39. Overall, how often was computer technology used in this course?

B.7. Section VII: Perceived effectiveness of computer use

Using the scale provided, please indicate how ***effective*** you believe the following computer applications were as part of this course.

A	B	C	D	E
Very Ineffective	Ineffective	Neutral	Effective	Very Effective

NA
Not Applicable

Please use *Not Applicable* if computer technology was not used for this course.

40. Instructional Supplements such as drill and practice exercises or tutorials.
41. Communication such as email, mailing lists, conferencing, ICQ or FirstClass.
42. Organizational applications such as databases and/or spreadsheets.
43. Analytical/Programming applications such as statistics, charting, graphing, drafting or robotics.
44. Expansive uses such as simulations or experiments.
45. Creative uses such as desktop publishing, digital videos, digital cameras, scanners or graphics.
46. Expressive uses such as word processing or on-line journals.
47. Evaluative uses such as electronic portfolios.

48. Informative uses such as Internet, CD-ROM or DVD.
49. Presentation applications such as PowerPoint and/or LCD projector.
50. Access applications such as a class website or class folder.
51. Overall, how effective was computer technology in this course?

B.8. Section VIII: Personal computer use

Using the scale provided, please rate the extent to which you agree or disagree with the following statements.

A	B	C	D	E
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
NA				
Not Applicable				

Please use *Not Applicable* if computer technology was not used for this course.

52. Computers make my job as an instructor a lot easier.
53. Computer technology is useful for other classes that I teach and/or my career.
54. I enjoy working with a computer.
55. Computers help me to teach the material in a meaningful way.
56. Computers make it easier to collaborate with students other instructors.
57. I can always find a computer to work on when I need one.
58. My teaching experience in this course was facilitated with the use of a computer.
59. I used a computer for this course because I had to not because I wanted to.
60. The use of computers improved the quality of my work.
61. The computer technology used in this course did not work the way that it was supposed to.
62. Using computer technology was necessary for me to do a good job in this course.

Additional comments

If there are any questions, comments or suggestions that you would like to add to improve this survey please add them on the sheet provided. We would love to hear from you! All comments welcome.

Thank you for taking the time to fill out our survey

References

Ausubel, D. P. (1963). *The psychology of meaningful verbal learning*. New York: Grune and Stratton.

Bates, A. W., & Poole, G. (2003). *Effective teaching with technology in higher education: Foundations for success*. San Francisco: Jossey-Bass Publishers.

Bloom, B. S., (Ed.). (1956). *Taxonomy of educational objectives: Handbook 1. Cognitive domain*. New York: David McKay Company, Inc.

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

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32–42.

Burns, T. C., & Ungerleider, C. S. (2003). Information and communication technologies in elementary and secondary education: state of the art review. *International Journal of Educational Policy, Research, & Practice, 3*(4), 27–54.

Clark, R. E. (1994). Media will never influence learning. *Educational Technology Research and Development, 42*(2), 21–29.

Ehrmann, S. C. (1995). Asking the right question: what does research tell us about technology and higher learning?. *Higher Learning, 27*(2), 20–27, Available online at: http://www.learner.org/edtech/rscheval/rightquestion.html.

Entwistle, N. (1994). *Styles of learning and teaching. An integrated outline of educational psychology*. London: David Fulton Publishers.

Good, T. L., & Brophy, J. (1995). *Contemporary educational psychology* (5th ed.). New York: Longman.

Grasha, A. F., & Yangarber-Hicks, N. (2000). Integrating teaching styles and learning styles with instructional technology. *College Teaching, 48*, 2–10.

Harris, M. H. (1999). Is the revolution now over, or has it just begun. *A year of the Internet in Higher. Education. Internet in Higher Education, 1*(4), 243–251.

Jonassen, D. H., & Reeves, T. C. (1996). Learning with technology: Using computers as cognitive tools. In Jonassen, D. H., (Ed.). *Handbook of research on educational communications and technology* (Vol. 1) (pp. 693–719). New York: Macmillan.

Kent, T. W., & McNergney, R. F. (1999). *Will technology really change education. from blackboard to web*. Thousand Oaks, CD: Corwin Press Inc..

Kozma, R. B. (1994). Will media influence learning. Reframing the debate. *Educational Technology Research & Development, 42*(2), 7–19.

Lambert, N., & McCombs, B. (1998). Learner-centered schools and classrooms as a direction for school reform. In N. Lambert, & B. McCombs (Eds.), *How students learn: Reforming schools through learner-centered education* (pp. 1–22). Washington, DC: American Psychological Association.

Laurillard, D. (2002). *Rethinking university teaching: A framework for the effective use of educational technology* (2nd ed.). London: Routledge.

Mayer, R. E., Moreno, R., Boire, M., & Vagge, S. (1999). Maximizing constructivist learning from multimedia communications by minimizing cognitive load. *Journal of Educational Psychology, 91*(4), 638–643.

McCombs, B. L. (2000). *Assessing the role of educational technology in the teaching and learning process: A learner-centered perspective*. The Secretary's Conference on Educational Technology 2000. <http://www.ed.gov/Technology/techconf/2000/mccombs_paper.html> Retrieved June 28, 2001.

Milliken, J., & Barnes, L. P. (2002). Teaching and technology in higher education: Student perceptions and personal reflections. *Computers & Education, 39*, 223–235.

NCREL (2002). Technology in Education. <http://www.ncrel.org/sdrs/areas/te0cont.htm> Retrieved March 29, 2002.

Parr, J. M. (1999). Going to school the technological way: Co-constructed classrooms and student perceptions of learning with technology. *Journal of Educational Computing Research, 20*(4), 365–377.

Piaget, J. (1955). *The child's construction of reality* (Margaret Cook, Trans.). London: Routledge & Kegan Paul.

Roblyer, M. D. (2003). *Integrating educational technology into teaching* (3rd ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Schacter, J., & Fagnago, C. (1999). Does computer technology improve student learning and achievement? How, when, and under what conditions?. *Journal of Educational Computing Research, 20*(4), 329–343.

Schank, R. C. (1993). Learning via multimedia computers. *Technology in Education, 36*(5), 54–56.

Shuell, T. J., & Farber, S. L. (2001). Student perceptions of technology use in college courses. *Journal of Educational Computing Research, 24*, 119–138.

Tabachnik, B. G., & Fidel, L. S. (1996). *Using multivariate statistics*. New York: Harper Collins.

Thornburg, D. D. (1999, December). *Technology in K-12 education: Envisioning a new future*. White paper commissioned for the Forum on Technology in Education: Envisioning the Future, Washington, DC.

Vygotsky, L. (1962). *Thought and language*. Cambridge, MA: MIT Press.

Ward, M., & Newlands, D. (1998). Use of the Web in undergraduate teaching. *Computers & Education, 31*(2), 171–184.
Weigel, V. B. (2001). *Deep learning for a digital age: Technology's untapped potential to enrich higher education*. San Francisco, CA: Jossey-Bass Publishing.
Winn, W. (2003). Cognitive perspectives and technology. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (2nd ed., pp. 79–122). Mahwah, NJ: Lawrence Erlbaum Associates.
Yazon, J. M. O., Mayer-Smith, J. A., & Redfield, R. J. (2002). Does the medium change the message. The impact of a web-based genetics course on university students' perspectives on learning and teaching. *Computers & Education, 38*, 267–285.
Zimmerman (1994). Dimensions of academic self-regulation: A conceptual framework for education. In D. H. Schunk, & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: issues and educational applications* (pp. 3–21). Hillsdale, NJ: Lawrence Erlbaum Associates.

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