The Integration and Effectiveness of ICTs in Canadian Postsecondary Education

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Prepared for:
2002 Pan-Canadian Education Research Agenda Symposium
"Information Technology and Learning"
April 30 – May 2, 2002
Crowne Plaza Montreal Centre Hotel
Montreal, Quebec

Abstract

On the basis of 39 EvNet surveys into learning, teaching, and information and communication technologies in higher education, we summarize much of what we know about infrastructure and institutional support, student, teacher, and institutional adoption of technologies, the integration of technologies into Canadian higher education, the motivation and goals of teachers and students, the computer, literacy and communication skills of students and teachers, and the integration of technologies with the learning styles of students and the teaching styles of instructors. We show that there is a deficit in institutional support for student and faculty computing in teaching and learning. Given the emphasis on critical thinking and analysis in learning and teaching, and the importance of feedback, collaboration, and discussion in coursework, we suggest that institutions of higher education should prioritize the purchase and installation of technologies that are strong on communications. This is consistent with deep approaches to learning among students and facilitative approaches to teaching among instructors who promote student self-directed learning. Communications technologies will do the most to advance the skills needed for the New Economy, the Digital Economy, or the Knowledge Economy of the 21st Century, and Canada's international competitiveness.

Introduction

Do colleges and universities always make the best decisions when purchasing, installing, and implementing information and communication technologies? Are such decisions guided by "best practices" in technology-based learning and teaching? In most cases, there is not adequate information about "best practices." Technology investments are usually done "blind". They are made by administrative and technical staff personnel who only have a remote awareness of what instructors and students need in the classroom and in distance education in order to effectively teach and learn.

In this paper, we will focus on the following factors that should form part of most information and communication technology implementation plans in higher education.

- Infrastructure and institutional support
- Technologies
- Motivation and goals of teachers
- Motivation and goals of students
- Computer, literacy and communication skills
- Learning Styles
- Teacher Styles
- Policy recommendations

We have summarized the conclusions from our statistical analyses of 39 EvNet surveys conducted by ourselves over the past five years. These include

- 10 campus student surveys (Campbell, Cuneo, et al)
- 6 campus faculty surveys (Campbell et al)
- 8 surveys of senior administrative personnel responsible for some component of learning, instruction, or technology at Canadian colleges and universities (Cuneo and Campbell)
    - Vice-presidents of information and communication technologies
    - Head Registrars
    - Head Libraries
    - Director of ICT networking and infrastructure
    - Head of computing and technical support
    - Director of Instructional Support and Academic Technology Centres
    - Director of Audio-Visual Services
    - Presidents of Faculty and Teacher Associations
- 3 annual online surveys of student learning in a computer-mediated communications environment (Cuneo and Harnish).
- 12 inquiry surveys (Cuneo et al)

Infrastructure and Institutional Support

Institutional support for online learning goes considerably beyond computing, networking, and technical support. It includes, at the highest level, policy-making in the Boards of Governors and Senate, as well as the president's office and vice-president's office. Also included are audio-visual, multimedia, and classroom technology services, the paperless record-keeping procedures in the Registrar's Office, and the library "learning commons" or "information commons".

Student Support

Most students now have personal computers connected to the Internet. In our ten student surveys, this varies from 50% to 90%. Students' own personal computers at home suit their needs better than the computers available to them through their colleges or universities. Less than half of students say that there are enough computers on campus, or that there is enough technical support for computers. Students spend only about 2 hours per week on campus computers compared to 6 hours per week on their own personal computers. While this may be a matter of preference, there is considerable variation between campuses in the provision of access. Some campuses provide students with just a little more than one hour per week of active access, while other campuses provide about five hours per week. At some institutions, students are able to do most of their work on campus computers; at other institutions, they have to do their work at home on their personal computers. This is probably based on the relative adequacy and availability of home or institutional computers, the appropriateness of software and functions, and differences in institutional disciplines and computer course requirements. Campuses have failed to provide students with 24 x 7 access to computers. They need to provide better computer access in order that students may complete their coursework.

In order to provide support for students, we have to understand their computing skills and needs. Between one-quarter and one-third of all students today experience computers before the age of ten. On average, students are 11 years old when they first touch a computer. This is much earlier than previous generations of adults, and has implications for campus support policies. Training will more often have to be provided for older staff and faculty rather than students. Since many students are now weaned on computers, they have little need for generic computer training workshops when they arrive on campus. Our data shows that campus computing services, such as computing support staff, help sessions, and workshops, have no influence on student's computing abilities. The requirement of computer use in courses has a negative influence on both female and male student computing ability. Demanding that students adhere to strict computer requirements in courses probably demoralizes students. The most positive influences on student computing abilities come from their own professors and instructors, from using computers in part time or full time paid jobs, and from self-help (students teaching themselves how to use computers).

Faculty Support

Our data raises policy questions about institutional responsibilities to support faculty use of computing in teaching. If it is argued that the computer is an essential or required tool for effective performance as a teacher, does the college or university have a responsibility to supply the faculty member with the "tools of their trade"? In our surveys, faculty split about 50/50

between working at home and working at a campus office. Only about 40% of faculty work on course preparation primarily at their campus offices. For those faculty members working at home, over 90% have a computer, but about two-thirds purchased their home computer out of personal funds. Only about 23% of faculty members were able to garner institution funds to help them purchase a home computer. About 14% of instructors are able to obtain research funds and 12% of professors are able to get other professional funds to assist in the purchase of a home computer in support of their teaching. Only 18% of teachers have dedicated high-speed Internet access from home, compared to 81% from their campus offices. If about 50% of faculty members do their course preparations at home, and if only 25% of faculty say their home computer equipment is better than their office equipment, then about 25 per cent of all faculty might be working with inadequate computer equipment at home in support of their teaching functions.

There has been a lot of discussion of the importance of campus institutions in providing computing workshops to faculty members to bring them up to speed on computing. However, our data suggest that this might not be a wise investment of resources. Only about 20% of faculty think attending institution workshops is important, and even less (10%) think attending external workshops and conferences is important. Overwhelmingly, faculty members rely on their own resources and those in their own personal networks to gain computing assistance. Ninety percent of faculty members think that relying on themselves and their access to manuals is important for computing assistance. About 40% of faculty will turn to their colleagues and friends in their own department or outside their department for help. If they have an immediate problem, about 40% of faculty will turn to technical support from their own institution. Colleges and universities might be wiser to invest in manuals and online help documentation, and personal computing staff support, rather than in workshops and conferences, in order to assist their faculty with computing problems.

Administrative Support

Online learning does not occur in a vacuum. It is deeply affected by the services and infrastructure provided by institutions of higher education. A digital library and paperless registrar administrative procedures are necessary for virtual campuses, pure online courses, and even hybrid courses in which face-to-face instruction is supported by web sites and computer conferencing. Our data suggest that online courses are more likely to occur on campuses that have gone paperless in the services they offer to students and faculty. University registrars in Canada have gone further than college registrars in implementing paperless office procedures and services. Digitization of the master course timetable has proceeded further than any other service. Modest advances have also been made in online student course registration, the production of student transcripts, the academic course calendar, and internal registrar office procedures. The least digitized are student financial aid records, personal student timetables, credit transfers between institutions, student entrance applications, and instructor submission of grades. Institutions that have digitized these administrative services in full or part are the most likely to offer web services directly to faculty members and students. Digital services offered to faculty include web course outlines (especially in colleges), remote viewing of student academic records, classroom and lab bookings, and electronic submission of grades and classroom booking requests. Digital registrars are also able to offer students remote program and course registration, e-mail account registration, and the viewing of their own records and timetables. We

have developed a model of the digital campus in which offering online learning is dependent on (a) digital faculty web services, and (b) digital student web services, both of which are dependent on (c) paperless administrative procedures in the registrar's office. The latter is dependent on (d) large campuses (high student enrollment), and (e) institution type (university administrative procedures are more digitized than colleges). In similar fashion, a digitized library information commons is a necessary condition for takeoff in offering online courses, or even courses in hybrid format to any significant degree. Space limitations do not allow us to expand on this topic.

Technologies

Student Adoption of Technologies

There are three kinds of students with respect to the employment of computers in courses.

- The *"positivists"* argue that computers are enjoyable, and they allow students to work more quickly and efficiently and save time.
- The *"strategists"* are the students who are also skilled at computing but in computers they see a golden opportunity for skipping class. They will email their professor or get notes off the web rather than attending class.
- The *"negativists"* are students who are very critical of the role of computers in courses. While they are also skilled using computers, they see computers as frustrating and adding to the amount of work they have to do, the amount their professors expect of them, and the amount they have to learn in a course.

Students have a double-edged view of technologies: they see computers and the Internet as important for their studies and for subsequent employment, but they worry about their role in the classroom. For example, 83% of students said that computers were necessary for their studies and 80% said they increased the quality of their work. However, 90% said that computers do not replace the need for lectures and discussion, and only 18% said communicating with instructors by email is better than talking to them face to face. The most popular computer application in college and university courses is word-processing. About two-thirds of all courses use some form of word-processing, most typically for typing assignments. Keyboarding skills are therefore a pre-requisite for a post-secondary education in Canada, though there is a wide variety of skill on the keyboard, all the way from touch-typing to single finger typing. About one-third of all courses use the Internet, web browsing and e-mail. About nine to eighteen percent of courses utilize computerized data analysis, presentations, assignments, testing, and multimedia or hypertext. Students are exposed to computer programming in only about two per cent of all their courses. Depending on one's basis for comparison, this suggests that there is not a high integration of more advanced computing into college and university education. Over half of all courses do not expose students to computer data analysis, or instructor computer presentations. Students are not exposed to computerized assignments in two-thirds of their courses. Three quarters of the courses do not expose students to computer presentations by other students, to computerized testing, or to multimedia and hypertext. At least ninety-two percent of courses do not expose students to any form of computer programming. One might argue that this is a skill that should be restricted to formal computer science course. On the other hand, it might be argued that this is a critical New Economy skill for all educated persons.

When we look at specific computer uses, there are five that stand out as the most intense. These are web browsing, chatting, downloading, processing, and printing. Word processing and printing are closely tied to course functions, and appear focused on the achievement of course objectives. They also do not necessarily involve the Internet nor connected computers. The others span academic and social life, and cross informal and formal learning. The web can be browsed for entertainment or for specific course objectives. Downloading can be of material for course assignments, or MP3's for entertainment (video and audio files). Chatting can be social or course related. In a sense, this is informal learning in the heart of formal education.

What computer functions are performed the least by college and university students? These are the more advanced computer and Internet functions, such as computer programming, construction of web sites, but also computer-supported collaborative learning (such as the use of collaborative messaging software). Email activity for social reasons (friends and family) is quite high, and is one of the few areas where female students are more active than male students.

There are two features of student use of computers for education that are noteworthy. First, they seamlessly integrate personal use of computers with serious coursework. This has sometimes been called "informal learning". Much of what students know in computer skills has been picked up informally rather than in formal courses. Students move easily back and forth between emailing family members about personal matters (61% do this) and emailing instructors about course matters (49% do this). At least in terms of e-mail, students do not draw a rigid boundary between communications within and outside courses. Second, students also integrate entertainment uses of computers and the Internet with coursework. Sixty-six per cent of students play computer games; 65% download MP3 audio and video files; and 65% engage in real time personal chats on such systems as ICQ. This easy integration of education with entertainment has led to the coining of the term, "edutainment", and to concerns among educators as to changing expectations in coursework. For example, many instructors now feel that they have to show video material in the classroom in order to hold students' interest in the course subject. Research elsewhere shows that students move easily back and forth between television and the Internet, and do not even have to switch monitors if they have access to WebTV.

There are two arguments about the so-called addictive effects of computers on university life. One is that computers take students away from studying and coursework. Students become addictive to computer games and surfing Internet sites, and spend less time in face-to-face interaction with their peers and on coursework. The opposite argument is that computers are an essential aspect of university life, all the way from academic coursework to communicating with peers and instructors. Of these two perspectives, our data appear to support the second. Students who spend more time on computers also spend more time in studying, and socializing with friends. In a sense, these are two flip sides of the integration of computers into post-secondary education. It has often been argued that there are two kinds of students: those who prefer face-to-face interaction with other students and with their professors, and those students who prefer to communicate with peers and professors by computer. The data shows that there is little basis for thinking that there are these two polar opposite types of students. In fact, if anything, students who enjoy face-to-face communications also enjoy e-mail and other forms of computer-based

communications. Many authors, such as Sherry Turkle, have noted the social function of computers. Students who are social in their offline lives are also social in their online lives.

How strongly do students support the integration of computers into higher education? There is some support for this, but it is not complete, and there are variations among the institutions studied. Most students see the value of computers in education, and recognize their importance for job skills and employment, but there is concern among a substantial minority of students over the rapidity of the introduction of computers into education, and its impact on the quality of learning and teaching.

- Only about five per cent of students think that computers should replace face to face contact in some courses
- About one-quarter of all students think that computers make teaching and learning too impersonal;
- Only about one-quarter of students think that computer-based instruction should replace some conventional class time and lab instruction;
- Only about 17% of students think they should be required to have their own computers, and about 40% think that their own institutions should supply students with computers. Only very few institutions supply students with laptops or notebooks, and at considerable cost with respect to increases in tuition or technology fees.
- One-fifth of all students think that computers have been introduced into courses too rapidly;
- Only about one-third prefers courses where students get to use computers.
- A whopping 90% of students think that computers do not replace the need for discussion and lectures.

The size of these opinions gives us pause for concern about how we are going about integrating computers into education. On the other hand, there is considerable support for the integration of computers and the Internet into coursework:

- About 80% of students think that computer skills are important for their student work while learning at a college or university
- About 65% of students think computer skills are required for the jobs they are thinking of moving into after graduation
- About 45% of students think that computers make learning easier
- About two-thirds of students think that campuses should offer courses on the use of computers
- Only about 12% of students would avoid a course because it has a computer component.
- About 40% of students think that computer competence should be required as a condition of graduation.

Now that we know the views of students, what do faculty members and teachers think about integrating computers into their teaching?

Instructor Adoption of Technologies

Contrary to what many of us may think, faculty members and teachers have higher rates of technology usage than students. Faculty have higher rates of using word-processing, web searches, and library searches. College and university teachers also have much higher rates of e-mail usage than students. For example, 89% of faculty members email students at least monthly, but only 49% of students e-mail faculty at least monthly. However, students engage more in computer games and computer programming. When we looked at the self-rating on computer skill, faculty and students had almost identical ratings, though older faculty and female faculty rate their computer skills lower than male faculty and younger faculty. We will return to instructor adoption and use of technologies below where we discuss skills and teaching styles.

Institutional Adoption of Technologies

What kinds of technologies do institutions of higher education purchase, install, and recommend to their faculty members and students? Commercial course management systems have become popular in the past few years. They strive to be the total package for instructors, offering web templates for course content, communication utilities, online testing, the ability to track students, and an interface with student registration and course databases. The most widely known system is WebCT. Our national survey of Instructional Support Directors suggests that about 50% of colleges and 80% of universities have purchased some form of a WebCt license. However, these figures appear deceptively high. There is a considerable difference between purchasing an entire campus license, or a license for specific courses, and actual adoption in courses. Only 11 per cent of instructors in the 2001 McGraw-Hill Ryerson survey indicated that they are currently using WebCt. Other systems with a presence in the academic marketplace are: IBM Learning Space, Centrinity's FirstClass, Web Board, Web Course in a Box, and Blackboard. Despite the popularity of these commercial packages, our Campus Computing Canada EvNet survey of the heads of technical and computer support points to other technologies that are more widely adopted and used by faculty and students. Our estimate from this survey is that 93% of university courses and 96% of college courses use the web in some form, 93% of university courses and 91% of college courses use e-mail, and 85% of university courses and 52% of college courses use computer conferencing. Our Registrar survey shows lower figures for colleges: 70% of colleges courses use e-mail, 69% use the web, and only 36% use computer conferencing. Regardless of the precise figures, there is little doubt that these are three of the most popular Internet applications on Canadian campuses. They come much cheaper than the commercial course management systems, which are now escalating in prices, putting a strain on higher education information technology budgets.

Integration of Technology into Higher Education

Our conclusion is that the integration of technology into higher education is a complex and long drawn out process consisting of at least the following six levels or stages:

1. *Purchase of a campus site license*, or partial license for use in particular courses.
2. *Adoption:* Instructor adopts a particular technology in specific courses.
3. *Course Design:* Integration of the technology by the faculty member into her or his course design. This is different from adoption. It is a critical step since a number of faculty members, on discovering at the end of their course that their students did not use

the technology they adopted, declare it to be a failure. The deep integration of the technology into the course design was missing. If the faculty member does not provide clear reasons why a technology is being adopted in a course, students will have little reason for using it, no matter how attractive it might appear to the faculty member.

4. *Access.* Easy access to the technology by the student. If students cannot gain access, or have difficulty getting access, to the technology, they will obviously not use it, or will use it very little. This step is often overlooked in the implementation of technology in higher education.
5. *Efficient Student Use.* There is a considerable difference between students struggling with course technology, and students making efficient use of it to advance their learning goals. This level or stage refers to technical usability and efficiency.
6. *Effective Impact on Student Learning:* The ultimate goal of technology is a positive impact on student learning. There is much research suggesting that technology makes no significant difference in student learning outcomes. However, some studies suggest that an intelligent pairing of learning goals with particular kinds of technology will advance learning. Communication and collaborative technologies are ideal for online debates that further critical thinking and analysis. Online testing software is ideal for rapid learning of facts and information.

In order that technologies be efficiently and effectively integrated into higher education, we need a clear articulation of the motivation and goals of teachers and students.

Motivation and Goals of Teachers

The McGraw-Hill-Ryerson (2002) national surveys of college and university instructors, now in its third year, asked instructors what they meant by "student success." In each annual survey, instructors tend to give similar ratings to the teaching goals or the "student success" components. In the 2001 survey, the percentage of instructors who selected the following items were:

1. Develop critical thinking and analysis skills (98%)
2. Ensure student master knowledge and discipline (90%)
3. Inspire interest in life-long learning (82%)
4. Teach students how to transfer and apply learning (82%)
5. Teach students to work ethically (81%)
6. Encourage personal growth (76%)
7. Teach soft communication and leadership skills (71%)
8. Help students acquire practical skill sets (65%)
9. Encourage a teamwork approach to problem solving (64%)
10. Prepare students for jobs and careers (63%)

These can be broken down into three stages of teaching and learning:

1. *Input* into learning and teaching: critical thinking and mastery of knowledge
2. *Process* of learning and teaching: transfer and application of knowledge; teamwork in problem solving; practical skills; and, soft communication and leadership skills.
3. *Output* or goal of teaching and learning: careers and jobs; personal growth; and life-long learning (meta-learning, or "learning how to learn")

This is the perspective of teachers and faculty members. What is the perspective of students? Why do they attend college and university?

Motivation and Goals of Students

A majority of students think that university courses should be linked to employment skills and qualifications (about 60% of all students across our surveys). Only about a third of students will still go to university if they think it has no economic payoff. An even larger percentage of students think that the university experience should encourage social and political responsibility, and activism. It would be interesting to see whether these students think social and political responsibility, and activism, could be implemented through Internet participation. In contrast, and despite the popular stereotype, a large majority of students (about 70%) are uninterested in the social aspects of university life. It is not clear that students think universities and colleges are relevant to their lives, including their intellectual life. About half of students think that higher education is not providing relevant intellectual experiences for their lives, while the other half disagree and seem quite satisfied. It is clear that there are two kinds of students: those who go to university in order to attain better employment, income and qualifications, and those who attend for its intellectual and social life. Neither group of students use computers more, but they use computers in different ways. Students who are more interested in the social aspects of university and college spend more time on video and computer games.

Skills

Computer Skills

One of the issues germane in this discussion is the origin of inequality in computing skills among university and college students. Why are some students more skilled and more confident of their computing abilities than other students? Some would argue it is because of different academic programs that students choose to follow. Students in engineering and computer science will be more skilled at computing than students in the social sciences and humanities. However, others argue that students bring these inequalities to the campus from their elementary and secondary schools, and their home-based computing experiences. Mothers have about twice as much effect on the computing ability of their daughters as their sons, and fathers have about twice as much computing ability effect on their sons as on their daughters. Given that fathers and men have greater access to computers than mother and girls, male students have an advantage when they enter universities and colleges. When we consider brothers and sisters, siblings have a greater influence on the computing ability of their own siblings than do parents. In all likelihood, there is a peer learning occurring among children that far predates any type of collaborative learning that these kids experience when they enter elementary and secondary schools, colleges, and universities. Home based and recreational computing has a much more powerful influence on student's later computing ability than parental or sibling influences, or influences coming from elementary and secondary school computing experiences. This is true for both male and female students. However, home based and recreational computing has a much greater effect in boosting the computing ability of male students than female students. This is probably due to boys' much greater access to household computer and Internet technologies. This affects their computer confidence, which in turn, later affects their ability to take advantage of e-learning.

This should have implications for policies on home-based schooling. The home is a critical learning environment that has too often been ignored in the focus on formal education, whether at the elementary, secondary, or post-secondary levels.

Are students sufficiently skilled in the computer software and programs they need for post-secondary education? It depends on what software we consider critical for learning. Students have the greatest self-confidence utilizing the most popular and widely used applications, such as email, word processing, surfing the internet with web browsers, and downloading MP3's. They are much less proficient and confident utilizing the more technical applications, such as setting up network connections and protocols, using a computing language to program, and installing and configuring computer hardware. Perhaps most alarming is that the gender differences widen for these more technical aspects of computing. Male students have more confidence than female students in every computing utility mentioned in our surveys. However, the gender gap is greatest for setting up network connections and protocols, using a computing language to program, and installing and configuring computer hardware. Given these data, colleges and universities need to mount special programs to train, and provide emotional support to women students in the more advanced features of computing and internet technologies.

Literacy Skills

There is a widely held belief that students can function better with computers than faculty. One of these areas of use is writing. Is it the case that students, given a greater perceived skill in computer use, might more likely and easily write their notes directly onto computers with little use of handwritten notes? In other words, are teachers more likely to write notes out in longhand, while students are more likely to write notes electronically onto a computer, including full drafts of documents? The answer, from our data, seems to be "no". Students are more likely than faculty to engage in writing notes and full documents on paper, while faculty are more likely to write directly onto the computer when making notes and writing long drafts of documents. We were rather surprised to discover from our surveys that there is little difference in self-perceived computing skill between faculty and students. Writing on paper rather than on computer may therefore not reflect computer skills, but a difference in style of note keeping. When making notes, students are often in a location different from their home workspace. They may more likely be making notes during classes and lectures, and when studying in the library, where they are less likely to have access to a computer (except at some laptop institutions). Instructors are more likely to be making notes in their campus office or their home office where they have access to a computer. Because of this difference in work place or studying location, parents and educators may have become too alarmist when they talk about the deleterious effect of computers on a declining student literacy rate. There has always been a fear that literacy will decline with the coming of the Internet. Students might be more attracted to images, video and sound files on the Internet and could lose the practice and art of writing. However, we must remember that much of the Internet concerns communications, and a considerable part of Internet communication is writing text. Students who are active in writing assignments, notes, drafts, and documents are also active e-mailers. They write often to their professor, their friends, and family members. The two forms of writing go hand in hand and reinforce one another. The general policy implication is that universities and colleges should encourage email use, not restrict its use as happens in some institutions because of the lack of computer lab space. On the other hand, the use of mobile computing, such as laptops, notebooks, and PDAs, is likely to

decrease students' use of writing notes in long hand and increase their reliance on electronic note taking.

Communication Skills

Communication skills lie at the heart of teaching and learning. The well-known Seven Principles of undergraduate teaching published by Chickering and Gamson (1987) under the auspices of the American Association of Higher Education place communication skills at the heart of high-quality higher education. They are important in the feedback instructors give to the student. They are important in how students collaborate with other students and respond to queries from teachers. Chickering and Ehrman later (1996) revised the Seven Principles to take into account the introduction of technology in undergraduate education. E-mail and computer-mediated communications became the core technologies in the revision of the Seven Principles. But how do students react to the introduction of technologies into traditional face-to-face relationships with other students, and with their instructors? In our 10 student surveys, 84% of students ranked face-to-face communication within classrooms and courses as very important or somewhat important. This outranked all other means of communication, including technologically assisted communication. Next in importance (70%) was face-to-face communication with other students outside the classroom. Third in importance (63%) was communication by telephone. Ranked fourth (61%) was face-to-face communications with professors. Computer-based technology only became a factor in the 5th most important mode of communication. Fifty per cent of students ranked e-mail with professors as the fifth most important communication for their course experiences. This was followed by e-mail with students (34%), newsgroups and listserves (12%), and real time computer chats (11%). In other words, students think that face-to-face communications, and even the telephone, are more important for the quality of their learning than computer-mediated communications. This should give us some caution in the rush to introduce technologies into the classroom.

Students who prefer face-to-face communications are less likely to engage in e-mail communications in order to get their schoolwork done. This, in turn, is related to computing ability and to background experiences in childhood. Students who are more confident of their computing ability are more likely to contact their instructor by email than seek a face-to-face encounter or telephone their instructor. Students less sure of their computing ability tend to wait for a meeting with their instructor. In terms of time, it might be argued that they are disadvantaged educationally. Women students are less confident of their computing abilities, and will try to contact their professor directly than by email. Women students thus have more difficulty operating in an e-learning environment.

We have to take seriously the design of the communications medium in the context of instructional design, and the learning styles of students. Should classroom communications be one-on-one between students, or between student and professors? Should students communicate and collaborate in groups of four or five? Should all class members share all communications within the class? This is typical of computer conferencing systems, such as IBM's Learning Space, or Centrinity's FirstClass. Should we encourage communications among students between different classes, and across the Internet? Should course material be considered a private affair between a teacher and registered class members, or should it be opened up to all students on campus, or to all students and even the public anywhere in the world? This is the concept of

"open and online learning." The Massachusetts Institute of Technology has begun an OpenCourseWare. Its courses will be open at no charge to anyone in the world with an Internet connection. While the World Wide Web surfer does not get credit for MIT courses unless they register, the content of such courses will be freely available so that many students and teachers can learn from and incorporate MIT course material into their own curriculum. This is the concept of open communication of information. It is not a new concept, but there is a lack of research on what kinds of learners benefit the most from such a communications design.

Learning Styles

Since 1995, we have been running an open and online e-learning system called "LearnLink" for 23,000 students. They are registered in specific courses with open online conferences containing course content, instructor and student material, and messages from all members of the class. Because there are no walls between courses, students are free to explore other courses, and even join the conversations and discussions in courses in which they are not registered. In several annual surveys, we have discovered that anywhere from 38% to 77% of students will access and read messages in the online conferences of courses in which they are not registered, and between 10% and 16% of students will send messages to these course conferences, even though they are not registered in the courses and cannot hope to receive any course credit for doing so. Our rationale for designing this online e-learning system in this way is that it provides a much more diverse set of perspectives in student course projects. There is a broader and deeper understanding of issues and problems based on online exchanges among students from radically different disciplines. Students from a sociology course may wander into an online biology course and provide a social perspective on a biological problem being considered by students in Science. This type of inter-course communication promotes interdisciplinarity and the clash of competing and even contradictory paradigms. To what kinds of learning styles does this open communications format appeal? Do students with particular learning styles benefit from this format? Are students with other styles disadvantaged? In order to answer such questions, we utilized the *"approaches to learning and studying"* measures and indexes from the British and Australian research on education. There are two major *approaches to learning or studying*, with several subtypes, as follows:

- Meaning Orientation: Students attempt to understand what they study; they relate this to their personal interests, and to larger conceptual frameworks and diverse bodies of knowledge. Emphasis is placed on questioning material that is studied.
    - *Deep Learning:* Students seek to understand deeply the underlying meaning of the subject material they are studying. They question what they hear in lectures or read in books.
    - *Comprehension Learning:* Students engage in free association between seemingly unrelated ideas, especially across disciplinary boundaries.
    - *Relating Ideas:* Students draw a concept map systematically connecting ideas to one another in a rational and logical manner.
    - *Intrinsic Motivation:* Students learn for the sake of learning. They are motivated to expand their knowledge and understanding of a subject matter, regardless of the bounds of a course or program. This is the foundation of "meta-learning", or learning how to learn for a life-time of continual learning.

- Reproducing Orientation: Students place emphasis on memorizing facts and restricting themselves to the minimal demands of courses.
    - *Surface Learning:* Students engage in rote memorization of facts. They skim issues superficially, and never absorb the material deeply.
    - *Syllabus Boundness:* Students stay within the bounds of the course outline prescribed by the instructor. The boundaries of the course outline define the outer limits of their potential knowledge and exploration.
    - *Extrinsic Motivation:* Students are motivated by external symbols of learning, such as qualifications and jobs, rather than intrinsic enjoyment of the subject matter. They do not enjoy learning for the sake of learning.

There is an additional *approach to learning* that does not fit easily under *meaning orientation* or *reproducing orientation*. This is called "strategic" or "competitive" learning. Students are primarily motivated by marks and grades.

How do students with diverse *approaches to learning* function in an open and online computer conferencing system? Our research shows that deep and comprehension learners, and those who relate ideas, are more likely to explore messages and other content in conferences in non-registered courses. They are interested in exploring the deeper meaning of course content in an interdisciplinary environment. Surface, competitive, and syllabus bound learners confine themselves to registered online courses; they do not explore non-registered course conferences. In fact, they are quite anxious about the level of their knowledge (or ignorance), and hesitate to post messages to course conferences. They are unsure of their writing style, and grammar, and are fearful that their ignorance will be ridiculed by classmates, and by lurkers or surfers from other courses who have crossed over into their course. So they have a lower e-mail message posting rate than the more confident deep and comprehension learners. This finding has been confirmed in online surveys we conducted in 1999, 2000, and 2001. In our campus student surveys, surface learners and extrinsic motivators complain about the extra work that computers have created for them. They feel that computers have increased what they are expected to learn, and the expectations by their instructors. Ironically, they are in favor of computers replacing lecturers and classroom discussion. In this way, they do not have to confront their peers, and can hide their ignorance and lack of confidence from their instructors behind the veil of web sites. In contrast, deep learners and intrinsic motivators are more positive about computers in courses. They feel that computers allow them to work more effectively.

Since learning styles interact with different kinds of computer technologies, we should expect a similar thing to happen with respect to instructor's teaching styles.

Teaching Styles

Our data is one of the first to give a glimpse into the relation between teaching styles and computer-supported instruction. Through a factor statistical analysis, we have extracted five teaching styles from our data. The first two styles are major; the last three styles are minor:

- *Sage on the Stage, or Directive lecturing*. This is a transfer of information and knowledge from the master teachers to the learning students who absorb the received information. Students are empty vessels into which information from the professor is poured.

Emphasis is placed on memorizing facts, concepts and principles, and multiple-choice testing.

- *Guide on the Side, or Self-Directed Learning.* The teacher acts as a facilitator, coach, guide, or animator. She or he encourages autonomy and collaboration in open exploration of knowledge by students. The teacher does not tell students what they need to know, but encourages students to explore material to determine what they need to know.
- *Personal Support and Encouragement.* The instructor provides strong emotional and intellectual support to the student.
- *Mirror Image and Cloning.* The teacher attempts to replicate images of himself or herself among his or her students.
- *Negative Feedback.* The teacher engages in extensive criticism of the students for their perceived failings, errors, and mistakes.

Our data show that female teachers and younger faculty members are more likely to be "guides on the side" and encourage self-directed learning. Male faculty members and older instructors are more likely to be "sages on the stage", to adopt directive teaching styles, and to be negative in highly critical feedback to students.

Regarding technologies, our data show that instructors who encourage self-directed learning among students are more likely to use collaborative and independent uses of technology, such as posting computer messages for the entire class, using email, accessing library databases, working in groups, and searching for materials on the Internet. On the other hand, some other forms of technology, such as word-processing essays or handing in computer files, does not differentiate instructors in terms of teaching styles.

Teachers who are more directive in the "sage on the stage" sense tend to use LCD computer projection display units, computerized testing, question and answer drill programs, and computer readable paper answer sheets. It is these technologies that are shunned by instructors who emphasize student self-directed learning.

It is also instructive to look at the motivation for faculty members, with different teaching styles, for introducing computers into their teaching. Instructors who lecture, who emphasize the transfer of information from themselves to students, and who are more directive, tend to introduce computers:

- To deal with large class sizes
- To cover more material
- To transfer the faculty member's knowledge of computing to teaching
- To compensate for the lack of teaching assistants
- To teach students more computing techniques

On the other hand, teachers who emphasize student self directed learning adopt computers in their teaching:

- To help students work in groups
- To get students to write more (normally not encouraged in large classes)

- To build informal links between students
- To communicate more effectively between teachers and students

In a policy sense, this means we need to take a closer look at the way teachers teach and the kinds of technologies that institutions buy and install. For example, if an institution is emphasizing self-directed learning, problem-based learning, or inquiry, they should not be adopting web-based or CD technologies that simply transmit masses of information to students. They should purchase and install communication technologies that encourage students to work independently and cooperatively in groups. These are collaborative messaging programs, such as IBM/Lotus Notes Learning Space or Centrinity's FirstClass. However, if institutions are looking to support instructors who wish to transmit large amounts of information, facts, concepts, and principles, with little peer communication among students or group work, they should be installing such Course Management Systems as BlackBoard or WebCT. Unfortunately, most institutions do not even have the evaluative teaching data to make such decisions. This is where our data could perform a valuable service for higher education in Canada and internationally.

Policy Recommendations

We make the following policy recommendations for the more effective integration of information and communication technologies into college and university teaching and learning.

1. Evaluation: Make evaluation of learning technologies an *a priori* requirement for the implementation of information and communication technologies. This is not "usability" or technical evaluation, but evaluation in terms of learning and teaching needs.

2. Diverse Teaching & Learning Styles. Incorporate learning and teaching styles into technology investment decisions. Too often, technical and administrative staff personnel make critical investment decisions with no faculty input, and with little awareness of learning and pedagogical practices. Implement somewhat different technologies for:

    a. Sages on the stage
    b. Guides on the side
    c. Deep and comprehension learners
    d. Surface and syllabus bound learners

    - Teachers and learners may be at risk if they are forced to work with technologies inappropriate to their teaching and learning styles.
    - Communications should be the centerpiece of many, if not most, technologies introduced in higher education.

3. Institutional Support for Student Computing:

    a. Since students have access to better computer equipment at home than through their colleges and universities;
    b. Since the affordability of computers is highly dependent on household income, creating an inequality of access to online learning;

c. Since students have access to campus computers for only about two hours per week;
d. Since higher education institutions have failed to provide sufficient on-campus computer access so that students can fulfill course expectations;
e. Since students with both on-campus and off-campus access to computers achieve a higher academic standing than those with no access or only on-campus access;
f. Therefore, the federal and provincial governments should create a program to subsidize the purchase of computers by colleges and universities for student use, and an additional program for home computer use based on an education tax savings plan.

4. Institutional Support for Faculty Computing

   a. Since the computer is a "craft tool", like paper, books, etc.,
   b. Since the home is the primary or shared workplace of 60% of all faculty,
   c. Since the majority of faculty working from home have slow-speed dial-up and poorer computer equipment purchased from personal resources
   d. Therefore, colleges and universities should provide faculty with at least one good computer and dedicated high-speed access from home.

5. Professional Development and Training:

   a. Since a majority of teachers and faculty members rely on their own resources, on peer networks or on-personalized computing staff assistance rather than attending workshops to obtain academic technology help
   b. Therefore, colleges and universities might be wiser to invest in manuals and online help documentation, and computing staff support, rather than workshops and conferences, in order to assist their faculty with computing problems.

6. Instructional Technology Support

   a. Since there is a risk that "best pedagogical and learning practices" will be lost in the attempt to fund technology
   b. Therefore,
      i. All academic technology positions must have a pedagogical and learning job requirement
      ii. All projects aimed at implementing technologies in teaching and learning must be evaluated for their contribution to student learning and pedagogical effectiveness

7. Gender: Campuses should institute policies to redress the gender imbalance in computing skill and computer access. Colleges and universities need to mount special programs to train, and provide emotional support to women students in the more advanced features of computing and internet technologies.