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From E-Mail to Virtual Reality: The Role of Technology in Supporting Learning

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Nowadays, it seems that nothing is quite the same as it was just a moment ago.

And if you blink, sneeze, or take the briefest moment to rest on your laurels, you're likely to miss out on something. The latest development or innovation. The newest and quickest shortcut. Or the most up-to-date electronic or digital gadget guaranteed to transform and improve your life.

In fact, it seems with the introduction of digital tools almost every aspect of our lives today is being changed and improved. From e-business, to tele-health, to basic human interaction, to the use of sophisticated digital libraries that support scholarship and the management of knowledge.

Learning is no exception. It too has been subject to the digital transformation. We can find evidence of the use of fast-evolving technical tools and infrastructure to support learning almost everywhere we look—both in our academic community and elsewhere. But it's also part of a much wider change in society. A change that has taken us online.

But before we continue, a precautionary note about the changing road ahead. Amid all this change, we must keep in mind that the technical tools are only the enablers. They are the products of a much deeper and profound shift in behaviour and social principles—a shift that we must first understand before we can implement truly effective learning systems.

Designing virtual learning environments

Online learning is alive and well in Canada—and throughout the developed world. Relating learning processes to the design of effective online learning environments is an area of international research—led in Canada by the TeleLearning Network of Centres of Excellence—in which I have been an active participant.

Essentially, every post-secondary institution is making some use of online materials to facilitate learning. Networked interaction ranges from universities that claim to be completely online, to individual instructors who use a local area network (LAN) for e-mail and posting class notes. There are also important applications for online learning in workplace education and training, and significant but more diverse activities in primary and secondary educational settings.

In traditional universities, learning has taken place in lecture theatres, classrooms, seminar rooms, laboratories, and a variety of other spaces. However, for a virtual university, these "spaces" might include virtual classrooms, virtual seminars, virtual laboratories, virtual study groups, individual study, and social encounters in a virtual

café. More important than the space itself is the kind of interaction that is supported and encouraged in these environments.

If we are to consider the latest research, the virtual approach may be the right one for some students. Current educational thinking suggests that lectures—largely based on information transfer—are relatively ineffective. It also suggests that the important process actually occurs when the learner transforms information into personal knowledge. This process is best achieved when the learner interacts with the information, the instructor, and other learners. To better understand this change in educational thinking it's worth taking a closer look at current theories of learning.

Three models for learning

These theoretical models of learning may be roughly divided into three classes: pre-theoretical models, classical behavioural and information-processing models, and the contemporary constructivist and socio-cultural models.

The instructional models used in most colleges and universities around the world can be regarded as "pre-theoretical." They assume that learning takes place when information is transferred from instructor and instructional materials to the learner. This occurs, for instance, in a lecture. For some time, it has been known that one-way presentation of information does not effectively sustain the attention of most learners for more than a few minutes. Learners often must copy notes during a lecture to study at a later time. This practice tends to postpone learning to a time and place where there may be no instructional support.

In contrast, the "classical behavioural" and "information processing" theories of learning introduced analytical models in which a complex learning goal is broken down into simpler components. They emphasize the importance of interaction and feedback, and serve as the foundation for systematic approaches to instructional design. Instructional design methodologies have been widely applied to the development of self-paced, individualized courses in distance education, military training, and corporate training. Computer-based learning programs using multimedia are often designed on principles originating in behavioural and information-processing theories. Although many computer-based learning applications of this type have been highly effective, only minor gains in learner achievement can be reliably obtained through this approach.

Throughout the 1980s and `90s, "constructivist" and "socio-cultural" theories gained in influence as alternatives to classical learning theories. Constructivist theorists do not believe that knowledge is a constant for each object or event. Instead, they believe that it is constructed by individuals as they interact with an object or an event in relation to their past experiences, their beliefs, and their current mental structures. For constructivists, learning is the process by which information is transformed into personal knowledge. Socio-cultural theories extend these basic principles to the development of the collective knowledge of a community. In a learning environment based on constructivism, teachers serve as coaches and guides, and learners are given significant cognitive responsibilities: analysis, synthesis, problem solving, and creativity.

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From the discussion of learning models, it is clear that knowledge is most effectively built from information in a learner-centred environment where collaboration and problem-solving are principal instruments. And in this environment, technology is called upon to support learning in a number of ways.

Video vs. face-to-face

Video broadcasting is one of these ways. The British Open University, one of the first to experiment with distributed learning, found that television broadcasts had value as a pacing mechanism, but that learning depended on the good use of distributed correspondence course materials, quizzes, and tutors. The University of Maryland, among many others, has used video to distribute lectures to satellite campuses where students using phone lines can ask questions. None of this is unacceptable, but it results in a diluted version of the face-to-face lecture format that is itself relatively ineffective.

Some of Canada's leading universities use two-way video conferencing to support their executive MBA programs. This extends a small, group seminar environment and can work very well in conjunction with other well-prepared activities and materials. But this approach does not do well on a larger scale. Two or three groups can be effectively linked by video conferencing. Beyond four groups, however, it becomes increasingly hard to manage.

More and more instructors are making their course materials—including class notes, work problems, and sample quizzes—available on the Web. Since many learners will print the materials, it essentially substitutes the Web for other publishing media and facilitates distribution. If, however, the Web-based materials are made interactive, there are new possibilities. Many instructors, for example, are experimenting with interactive learning materials that allow the learner to run a simulation and try out a variety of "What if?" situations. The learning material can also involve multimedia animations, role playing, and much more. These are activities that were not possible with course notes or a textbook. Although they are a significant improvement, they still do not replace collaborative activities with fellow learners.

For several decades now, computer based training (CBT) has been the tool of choice for much workplace training. How does it work? After accessing it on a CD-ROM or on the Web, a typical learner is led step by step through a display of information, application of the information, and then some testing. Based on responses to the test, the learner proceeds either to the next stage or to remedial work. Although this behavioural approach works well for relatively routine individual learning, there are seldom opportunities for collaboration. The approach has generally not been successful in college or university applications.

Based on the principles of "constructivist learning," the goal in designing a virtual learning environment is to support student-centred approaches to collaborative learning and knowledge building. A primary prerequisite for the environment is that it must allow rich discourse between students and instructors, and between individual students. This can be achieved with both synchronous and asynchronous conferencing

systems. (Discussion is “synchronous” when all participants are online at the same time; it is “asynchronous” when learners post arguments and responses independently, but usually the same day.) Experience suggests that for many purposes, asynchronous conferencing supports the most effective discussions and this is easily supported with a computer based conferencing system.

In discussing the merits of the technical systems, it is important to remember that different approaches may have merit in different circumstances. For an isolated learner in northern Canada, Web access by a slow dial-up phone line is much better than no access at all. As a result, when assessing learning environments, we often judge many unfavourably (and perhaps unfairly) by comparing them to those relatively rare environments where four or five well-prepared learners sit around a table, exchanging ideas and arguments with an engaging, intelligent professor. The real situation in many universities and colleges can be quite different. Often, it is classes with hundreds of students crowded into a lecture theatre, or learners who cannot travel to the institution and have little choice but to use correspondence courses with little help from instructors.

Virtual drawbacks

As popular and useful as all these learning methods have become, the sciences and engineering have been slow to adopt online learning because of a number of very real problems. One problem is mathematics. It is hard to find Web tools that allow interaction with mathematical equations, although some useful tools are under development. Another problem? Although lab experiences, where learners apply theory to physical problems, can be handled online with the use of simulations, progress has been slow in extending the technique to all areas. Some lab experiments are difficult to simulate. Only in certain cases can the remote learner control a physical experiment by "tele-operation”—by remotely setting and manipulating controls on a physical apparatus.

A related situation is one where learning depends crucially on physical cues of the environment—flying an airplane, for instance. In such cases, a flight simulator is used and is a good example of virtual technology at work. In spite of discipline-specific difficulties, there are many areas (some surprising) where the virtual learning experience is effective—in the fine and performing arts, for example. Although there are problems in creating an online equivalent to a teaching studio or rehearsal hall, Simon Fraser University’s very successful online dance course called “Dancing in Cyberspace” is a prime example of how useful the new technology can be.

At the former Technical University of British Columbia (and now at the Surrey campus of Simon Fraser University), one of the principles guiding our design of learning environments was to combine enhanced access for learners with effective pedagogy. Whenever possible, we maximized collaborative learning. As a result, all courses are partially online, while some are 100 percent online. To implement this, we have adopted a number of delivery models that provide a framework for achieving effective pedagogy within operational constraints—keeping in mind the need to enhance access.

The first delivery model is the "computer-mediated classroom." In this 100 percent online model, the materials are on the Web and include learning objects with interactive multimedia simulations. Collaborative learning takes place in a variety of small-group and large-group asynchronous conferences.

The second model is known as the "presentational co-operative." Learning materials are Web-based, as in the computer-mediated classroom model. But the collaborative learning takes place in face-to-face sessions where learners participate in small-group discussions and problem solving. This 50 percent online model is helpful in areas that involve subjects that are difficult to discuss online—mathematics, for example.

The third model is the "mixed collaborative." This 75 percent online model is a combination of the previous two models—with face-to-face discussions and online discussions in alternate weeks.

The fourth model, the "Studio-lab," is a 25 percent online model that has online presentations of Web-based materials. There is, however, extensive face-to-face time in the studio where learners interact with a master teacher. A major research issue is to find ways to put more of the activity online.

The fifth model is "flexible study." This 100 percent online model is, in essence, the online version of the tried-and-true correspondence course. The course materials are all Web-based and rich in interactive learning objects and quizzes. There are, however, generally no opportunities to interact with other learners. Although this model does not represent the best pedagogy, it offers learners the ultimate in flexibility and access. As a result, it's a useful way to pick up a course missed because of illness, to challenge a credit in areas where the learner has a good background, or to retake a course not successfully completed in another model.

Given current technology and the understanding of online learning methodologies in different disciplines, we believe these models represent the best compromise we can offer our learners. We also expect that these models will evolve. Although there will always be a place for human contact, it will soon be possible to complete full educational programs in all disciplines without any face-to-face meetings.

Looking to the future

What does the future hold? Research directions being pursued at SFU, and in larger research programs across Canada and internationally, address a number of possibilities.

First of all, at SFU as part of a Canada-wide consortium supported by CANARIE Inc. (an Internet development organization headquartered in Ottawa), we are studying how to assist course creators by making the nuggets of a learning experience—we call them learning objects—available for reuse through distributed repositories. Course authors will search the repositories using peer-to-peer networking, the technology that was given prominence by the music-sharing Web site Napster.

Second, a cross-Canada network of interdisciplinary researchers led by SFU is investigating the use of games and simulations in online learning. Many have remarked

that game technology is powerful and inexpensive and should be applicable to support learning. But little is known about the specifics of how game playing leads to learning.

And third, we are studying how broadband networks can be used to link virtual-reality based environments where, for example, dancers can collaborate at a distance in the creation, rehearsal, and performance of new works.

It is clear that the use of technical tools and infrastructure to support learning is part of a much wider and more profound change in society. And as society becomes more and more reliant on these tools, we must be careful to remember that they are only tools—created, used, and guided by humans who strive to help others learn in new and imaginative ways. Despite the plea for caution, however, we must allow ourselves to be inspired and to remember one important detail. The future is limited only by our imagination.

Acknowledgements

In writing this rather personal account I have drawn extensively from the experience of my colleagues at the former TechBC (now Simon Fraser University, Surrey). In addition, I am particularly indebted to Dr. John Nesbit for his help.