Research and Evaluation

At the time of my writing this book, no conventional campus-based higher education institution has had extensive experience in using the Internet and multimedia in a sustained and intensive manner for teaching purposes. This means that successful and sustainable planning and management strategies have yet to be clearly identified and documented.

Given the rapid speed with which new technologies for teaching are infiltrating even the most cautious and conservative of universities, and the lack of experience in the use and management of such technologies, the case for researching and evaluating the applications of these new technologies is obvious.

Such research and evaluation, though, needs to be focused on the right questions, and it needs to be done in ways that help inform planning and management decisions. In other words: What seems to work and what doesn't in planning and managing new technologies for teaching and learning?

Evaluating Teaching and Learning Through New Technologies

The place where most faculty members and graduate students tend to start is by evaluating the relative effectiveness of technology based teaching compared with traditional face-to-face teaching. Although this may be necessary to win buy-in from reluctant faculty members, this particular research agenda is frankly a waste of time. The results are already known.

Asking the Right Questions

There have been many thousands of well-conducted research studies comparing a televised lecture, or computer-based learning, or print-based correspondence education, or any of a range of other technologies, with classroom lectures. Furthermore, there has been a remarkable consistency of results dating back from the early 1970s: the most common finding from all the carefully conducted research with well-balanced comparative groups, objective learning measurements, and large enough samples is that there is no significant difference in student performance.

The generally accepted conclusions from all these studies is that teaching with technology does at least as well, if not better, as conventional, classroom teaching (see, for instance, Schramm, 1974; Clark, 1983; Moore and Thompson, 1990; Russell, 1999).

It is often further inferred from the no-significant-difference results that in the end, it does not really matter what technologies are used for teaching because there is "no significant difference" between their use and classroom teaching. This, however, is a false inference, because the research design has usually deliberately excluded other factors than the original classroom learning objectives. These other factors may be the crucial deciding factors that make it worthwhile to use a particular technology or not.

There are several reasons for the no-significant-difference results. The first is that the traditional classroom is nearly always used as the basis for comparison. In other words, can the new technology achieve the *same objectives* as those sought in the classroom? Very often, the same teaching method (for example, didactic lecture) is then applied to the new technology. Indeed, quantitative researchers such as Clark (1983) insist that for experimental reasons, all other conditions *except* the choice of technology or teaching medium must remain the same for a true scientific comparison to be made.

The problem with this kind of research is that very often, dif*ferent* or new learning outcomes can best be achieved through the use of technology. For instance, a didactic lecture may be concerned primarily with content acquisition and comprehension, whereas a Web-based course may be more concerned with students

seeking, analyzing, and evaluating information. Restricting technology merely to imitating the assumptions and goals of classroom teaching in order to assess scientifically its comparative worth is like cutting two legs off a horse to see if it can run as fast as a man.

Thus, although straight comparisons of face-to-face teaching with technology-based teaching are not very helpful, research into the unique contributions that technology can make to teaching and learning is. Such research would focus on the relationship between the use of a technology and different levels or types of learning (see Laurillard, 1995, for a fuller discussion of this).

Another problem with straight, quantitative, comparative research is that there are usually greater differences in learning outcomes *within* a particular technology or medium of teaching than *between* them. Thus, a good lecture ' will always have better learning outcomes than a poorly designed multimedia program, and *vice versa.* One important lesson from this is that good technology does not save bad teaching. It not only makes it worse but also spreads it more widely. However, research that focuses on the requirements for the effective use of a particular technology will be helpful. Such research might focus on forms and levels of student-machine **in**teraction, interface design, and designs that support learners working in isolation.

Teachers, learners, and technologies are all amazingly flexible in their abilities to teach and learn. If one technology is not available to a teacher, then she may get just as good results using another approach, although there will be other losses (and some gains), such as the teacher spending more time or the student having to work harder. These "side effects" are often the truly important benefits (or limitations) of using new technologies, but they are usually excluded by comparative research design.

In developing strategies for research and evaluation, we need to look at a wider range of factors than the ability of technology to replicate classroom teaching. The ACTIONS model following indicates some of these factors.

The ACTIONS Model

In an earlier publication (Bates, 1995), I identified the following factors that need to be considered when evaluating the effectiveness of different teaching technologies. These factors may be summarized by the acronym ACTIONS:

Access and flexibility: How accessible is a particular technology for learners? How flexible is it for a particular target group?

Costs: What is the cost structure of each technology? What is the unit cost per learner? How do costs differ between technologies within a particular context?

Teaching and learning: What kinds of learning are needed? What instructional approaches will best meet these needs? What are the best technologies for supporting this teaching and learning?

Interactivity and user-friendliness: What kind of student interaction does -this technology enable? How easy is the technology to use?

Organizational issues: What are the organizational requirements, and the barriers to be removed, before this technology can be used successfully? What changes in organization need to be made?

Novelty: How new is this technology? How reliable is it? How will this technology contribute to institutional renewal?

Speed: How quickly can courses be mounted with this technology? How quickly can materials be changed?

Thus, new technologies for teaching do need to be researched and evaluated, but the evaluation should not be restricted merely to replicating classroom learning outcomes. Research and evaluation questions that are more relevant might include these:

- *What impact will this application of technology have on student access and flexibility to learn*? Will this enable new markets to be reached or new needs to be served, or will this technology disadvantage learners that we currently serve?

- *What are the cost advantages and disadvantages of applying this tech*nology? What will be the impact on costs of increasing student numbers this way compared with increasing student numbers through traditional classroom teaching? What happens to costs if student enrollments drop? At what point in terms of student numbers does this technology become more cost-effective than other approaches?

- *What teaching functions* and learning *outcomes seem to be more easily or more effectively achieved through the use of this technology*? What learning objectives appear difficult to achieve using this technology. Will this technology enable us to achieve learning objectives previously not considered, and are these outcomes worthwhile?
- *What forms and levels of interaction can be achieved in using this technology?* Does it give reliable and comprehensive feedback to students? Can students ask open-ended questions and receive prompt .responses? Does the technology encourage or facilitate discussion between students? What kind of thinking-comprehension, analysis, problem solving, decision making, or evaluation-does this technology encourage? Is the technology easy to use by learners and teachers?
- *How easy is the technology to operate and manage?* Is the necessary infrastructure already in place or does it need to be built? Does the institution have sufficient technical, production, and educational staff available to support this technology? If not, can they be found locally at reasonable cost? Is the technology demanding of technical support time? Does it require a lot of help to be provided to students? Will the administrative systems have to be changed to accommodate the planned uses of this technology?
- *How reliable and stable is the technology?* Has it been thoroughly tested before being made available to students? How much training is needed both for teachers and learners before this technology can be used effectively? To what extent is the department or institution prepared to support new initiatives in this area?
- *How quickly can courses be mounted or materials developed using this technology?* How quickly and easily can changes be made or new material added? How quickly and easily can the materials be distributed to learners?

These questions provide a basis for the selection of technologies and their subsequent evaluation. (For more details on selecting and using new technologies for teaching and learning in higher education, see Bates, 1995.)

Researching Software Applications

The choice of appropriate software to support the development of technology-based courses (course author in software) is a complex issue for several reasons. There is a wide range of course authoring products available, new products appear on the market all the time, and existing products may be substantially improved in later versions. In addition, course developers need to be aware of general software developments that can dramatically affect technology-based teaching, such as learning objects (see Chapter Eight for more on learning objects), new languages such as Java, video servers, screen sharing, and search engines. Merely keeping up to date with software developments is a full-time job.

For these reasons, there is an understandable tendency to shy away from doing the research necessary to identify the "best" software solution. Consequently, "Paulian conversion" is a common form of decision making: an administrator or professor attends a conference or trade exhibition, sees a particular technology, and is immediately "converted" in the same manner as was St. Paul on the road to Damascus. Thereafter, all course development must be forced into this particular technology.

Some institutions have tried to standardize on one course authoring system in order to keep down administrative costs. This is a major decision, one that will have implications for all instructors wanting to develop technology-based courses. The drawback to standardizing on a particular type of course

development software is that there are many different ways in which one can teach, and no software yet exists that suits all purposes. For instance, the software needed to develop a Web-based course with a heavy emphasis on classroom discussion will be very different from the software needed to develop a multimedia CD-ROM based on an expert system for decision making. Even in courses totally confined to Web delivery, a wide range of teaching approaches is possible, depending on the nature of the subject matter and the preferred teaching approach of the faculty member.

Thus, any attempt to impose a single course authoring software solution on a whole institution is likely to impose a serious restriction on academic freedom and could lead to a highly undesirable uniform approach to teaching across all subjects. It is particularly important that administrators or computer systems managers do not make such decisions without full prior discussion with faculty members.

It is not surprising that research into different Web authoring software, such as WebCT, Lotus Notes Learning Space, and so forth, for supporting technology-based teaching, is seen as an essential activity, and indeed it is. Several Web sites provide comparative analyses of different Web-based course authoring software (see, for instance, http://www.ctt.bc.ca/landonline/; http:// sunil.umd.edu/webct/; http://wwwumanitoba.ca/ip/tools/ courseware/). The problem is that these Web sites generally focus on technical issues (reliability, speed, server requirements, and so forth) and sometimes also on administrative and cost issues. Although it is necessary to consider such factors, they are not sufficient for teaching and learning purposes. Research should be focused just as much on the compatibility of different software with different teaching approaches as on administrative and cost factors.

The complexity of such decisions also argues for a central academic unit with special expertise that can track new developments in software and their applicability to teaching and learning, and can act as a guide and educator for faculty members on software developments.

Although evaluation of appropriate course authoring software should be an ongoing activity, it is only one of many other important factors that can influence the success or otherwise of technology-based courses. Indeed, there are many examples of technology-based courses that have been successful despite poor decisions being made on appropriate software. In other words, software evaluation should not be the sole or even main priority for research.

Learner Impact

In addition to measuring learning outcomes, it is important to assess the other effects on learners of technology-based teaching. One of the great challenges facing traditional campus-based institutions will be getting the balance right between face-to-face and technology-based teaching, particularly for young freshmen coming direct from high schools. Also, with increasing emphasis on lifelong learning, widening access, continuing professional education, and applied graduate programs, the demographics of the student body are likely to change. It will be important to track learners' responses to a shift in teaching methods and to identify any differences in response by the type of student.

For students, there is often a trade-off between loss of direct, personal contact and increased access and flexibility. There is also a trade-off between the costs of getting to campus and the costs of acquiring a computer, software, and Internet access. Response again is likely to vary with demographics. My experience suggests that technology-based learning is more acceptable and more affordable to working adults. Young freshmen on campus tend to prefer more conventional forms of teaching and need to be eased gently into learning via technology, because it requires more self discipline and personal responsibility for learning.

Students also have different preferred learning styles. Some are social learners, others prefer to study independently, others like a mix. Some learners are not happy working with a computer, either because of preferred learning style or lack of computer literacy. Some students may be competent at word processing but not at using t he Internet, or vice versa. It may be necessary to implement special programs to assist learners in computer literacy or in developing appropriate approaches to technology-based learning. It may be necessary to provide a choice of delivery modes (face-to-face or distributed learning), but this will be an expensive option. Generally, though, the responsibility for dealing with different learning styles and

preferences is likely to fall on the regular instructor, and well-conducted research should be able to provide guidance on the role of technology in meeting different preferred learning styles.

The need to adapt to the different needs of different learners is not really something unique that arises from the use of technology; technology merely exacerbates a general and already-existing problem. Nevertheless, carefully designed evaluation studies can provide invaluable feedback for teachers and decision makers about the appropriate role and impact of technology on an increasingly diverse student population. Teaching at universities and colleges will become more like fine-tuning a high performance engine.

Academic Technology Organization and Management

Although this book provides some strong guidelines (probably too strong) for the organization and management of technology for teaching and learning, there is still not enough experience to be confident that these will work, at least in all contexts. Experimentation and constant monitoring of organizational and management strategies, and particularly sharing of experience between different institutions, will be needed for some time. There is a need for some national, or better still, international benchmarking exercises to identify and measure best practice in the organization and management of technology for teaching purposes.

Cost-Benefit Analysis

Cost-benefit analysis attempts not only to relate the costs of activities to the benefits (and disadvantages) of a particular strategy **but** also to identify the underlying relationships between costs and benefits.

Two major cost-benefit studies of the use of new technologies have been developed in parallel in the United States and Canada. Jewett (I 998) and Young (I 998) have recently completed a study on behalf of the U.S. Department of Education. This study looked at twelve case studies using new technologies, which focused primarily on live instructional television and computer-based learning. The Canadian study (Bates and Bartolic, 1999), funded through the Canadian government's National Centers of Excellence-Telelearning project, focused on six case studies of on-line courses.

Although the U.S. and Canadian projects were separate, there has been close communication between the researchers in the two studies. Both projects developed somewhat similar methodologies for analyzing costs. The Canadian study collected three kinds of cost data-production and delivery costs, capital and recurrent costs, and fixed and variable costs-and identified three main areas of benefits-*performance-driven* benefits, including learning outcomes, student satisfaction, instructor satisfaction, and return on investment; *value-driven* benefits, including access, flexibility, and ease of use; and value-added benefits, such as reduced traffic and parking needs, spin-offs of new products and services, and increased revenue generation.

In each case study, data were collected under each of these categories (it should be noted that "benefits" could be negatively as well as positively assessed, for example, reducing instead of in-creasing access). Some of the preliminary findings from the Canadian studies (Bartolic and Bates, 1999) are as follows:

- *The cost structures of on-line learning are different from those of face-to-face teaching and print-based distance learning technologies.* Initial direct investment costs for on4ine learning are higher than those for face-to-face teaching but lower than for print-based distance teaching; on-line learning costs have some economies of scale compared with face-to-face teaching, but the economies of scale for on4ine learning are lower than those for print-based teaching because of the increased interaction between teachers and learners in on-line learning.

- *Start-up costs for specially designed on-line learning courses are substantial and often unanticipated*, especially in instructor time and administration. However, costs settle down quickly after the first offering of a course.
- *On-line learning courses can provide both quality learning and a return on investment*, even with unanticipated start-up costs.
- *Student reactions were mixed.* Reactions to on-line learning seem to be influenced by a number of factors. It seems to be more acceptable to students who cannot access the campus and to part-time students. There are definite trade-offs, not just in convenience and access but also in quality of learning. Many (and especially those working in a second language) preferred the asynchronous forms of on-line discussion and the international perspective such courses provided; others, especially the on-campus students, missed the spontaneity and simplicity of synchronous spoken communication
- *Design issues are just as critical for on-line learning as for other forms of teaching.* The organization and size of discussion forums are critical factors for success, as are the intervention strategies of tutors. both face-to-face and on-line teaching, and the effect of dropping below ten students per course was not measured.)
- *In the context in which the studies were done, the direct costs per student of specially designed on-line courses were similar to those of face-to-face* instruction *in the range of twenty to forty students per course per year over* afour-yearpe7iod. Below twenty students per course, face-to-face teaching was cheaper per student; above forty students per course per year, on4ine learning became increasingly cheaper per student. (These comparisons assumed similar student-teacher ratios for both face-to-face and on-line teaching, and the effect of dropping below ten students per course was not measured.)
- *On-line learning allows for the development of courses that can be delivered on a global scale in a cost*-effective *manner*. But global courses are likely to represent a niche market, and demanding conditions need to be met to be successful.
- In *certain contexts, university-level on-line courses or programs can fully recover all their costs or make profits from student fees and franchises without government subsidies.*
- *Indirect (or value-added) as well as direct benefits of on-line* learn*ing were identified.* Indirect benefits include impact on campus transportation patterns, and hence on environmental issues, on classroom and other building requirements, and on the development of new products, services, and sources of revenue generation. The indirect benefits appear to be even more important than the direct benefits, although further research is needed in this area.
- *Indirect as well as direct costs of on-line learning were identified.* Indirect costs include network infrastructure and technical support services, use of central services such as registration and the finance office, buildings, and space requirements. Although on-line courses share some features with face-to-face teaching when it comes to indirect costs, there are significant areas where the indirect costs of on4ine learning are different from those of face-to-face teaching, especially space and building requirements. Indirect as well as direct costs need to be considered when comparing face-to-face teaching with technology based teaching. More research is needed in this area.

It should be emphasized that these are preliminary results specific to certain contexts, and such studies need to be replicated in many other different contexts.

Conclusions

Because of the emerging context of technology-based teaching, especially for traditional campus-based universities and colleges, research and evaluation is essential. However, it is important to focus on the unique educational characteristics of these new technologies and to ensure that the wide range of factors influencing the successful use of new technologies is studied.

There is a need for constant evaluation and research of new technologies. In particular, the assessment of the educational and academic implications of their introduction and the potential indirect benefits of using new technologies suggests that research and evaluation should be a significant function of a central

academic technology unit. This would help ensure that research and evaluation are focused on the needs of the institution and that the results and implications have wide impact throughout the institution.