With technology developing at such a rapid pace, teachers and administrators are constantly being faced with the need to make decisions about appropriate technology for teaching. What are the unique teaching roles (if any) of video, audio, and text? What are the implications of broadband access for our Web course design? How will speech-recognition software affect course design? Should I use a videocassette or include the video material on the Web site? Should we be developing in SGML or XML or stay in html? Is Blackboard better than WebCT? Is the new software version better than the old one? (Not necessarily, from experience!) If we don’t change our existing courses when a new technology appears, what are the implications?

It is impossible for any single teacher to stay abreast of new developments in technology. Even in large universities with specialized centers for the development of technology-based teaching, it is difficult and costly to keep monitoring and assessing the implications of each new development in software or technology. Yet it is easy to get caught unaware by new developments. The first Web course in higher education was not developed until 1995. However, any distance education program that didn’t start moving its programs onto the Web fairly soon thereafter would have lost competitive advantage and credibility for the institution.

In such a fast-changing environment, decision makers need a framework or set of criteria to guide them. This chapter attempts

to build this framework, based on theory, research, and practice, by exploring the relationship among student differences, subject requirements, desired approaches to teaching and learning, choice and use of technology, and the availability of resources and institutional support. Consideration of all these factors should influence the design of teaching with technology. Our aim is to set out the general framework in this chapter, then in following chapters to apply this framework to the detailed planning, design, and delivery of technology-based teaching.

Models of Media Selection

There are plenty of models for media selection. Romiszowski (1988) provides a good example of a systems approach to instructional design and media selection. Reiser and Gagné (1983) discussed ten models of media selection and identified a number of common characteristics of such theoretical models.

There are several problems, though, with applying most models to the use of technology in teaching. First, most concentrate primarily in matching a particular medium to a particular, fairly short, instructional event, such as reading a map. In such models, the teaching or learning process is fragmented into basic elements of activity (for example, understanding the symbols on a map) against which a particular medium is selected.

The usual method is to adopt an algorithmic, reductionist approach to decision making, requiring many different media for even a small amount of teaching (for example, a map uses symbols, therefore graphics are needed to represent each symbol and text or audio are required to provide an explanation of each symbol). In reality, it is not practical for a teacher to go through all the individual activities in a single lesson and make this kind of analysis. Also, in such models the rules or criteria for matching a medium to a task are not usually spelled out. It is intuitive that a graphic will be needed to represent a symbol on a map, and there is no theoretical basis to explain why text might be better than audio (or vice versa) for explanation of the symbol. Furthermore, these models rarely deal with noninstructional, practical issues, such as costs and organizational requirements.
An Alternative Framework

A model for selecting and applying technology is needed therefore that has the following characteristics:

- It will work in a variety of learning contexts.
- It allows decisions to be taken at both a strategic, institution-wide level and at a tactical, instructional level.
- It gives equal attention to educational and operational issues.
- It will identify critical differences between different media and technologies, thus enabling an appropriate mix to be chosen for any given context.
- It is easily understood, pragmatic, and cost effective.
- It will accommodate new developments in technology.

Bates (1988) first developed and later refined (Bates, 1995) the ACTIONS model to meet the above criteria. It was intended as a set of questions to be asked by distance educators when making decisions about investment in technology and when choosing specific media and technology applications for a course. ACTIONS stands for:

A Access: how accessible is a particular technology for learners? How flexible is it for a particular target group?
C Costs: what is the cost structure of each technology? What is the unit cost per learner?
T 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?
I Interactivity and user-friendliness: what kind of interaction does this technology enable? How easy is it to use?
O 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?
N Novelty: how new is this technology?
S Speed: how quickly can courses be mounted with this technology? How quickly can materials be changed?
Bates argued that these questions should be asked in any educational context. However, the answers will depend on the context in which they are asked, including the teacher's own preferred ways of teaching and the institutional context in which the teaching will take place.

He also argued that decision making in this area cannot be driven by hard and fast formulae or rules:

Decision making about technology . . . is a complex process, requiring consideration of a great number of factors. Decision making in this area is also about personal choice, driven as much by values and beliefs as by technical considerations. These different factors cannot easily be related to one another quantitatively. In the end, an intuitive decision has to be made, but based on a careful analysis of the situation.

Fortunately, one of the great advantages of the human brain over computers is that the brain is far better than a computer at handling this kind of decision, provided that people have the necessary information and an appropriate framework for analysis and decision making. From this point, decision makers can then come to their own conclusions intuitively about the best mix and match of specific technologies to use, taking into account not only the factors enumerated, but also all the local conditions which only they can know fully. (Bates, 1995, pp. 59–60)

This model has been applied both formally and informally in a number of different settings and has been found to be practical and useful (see, for instance, http://www.cotr.bc.ca/cdc/Distributed_Learning.htm; Haque & Garibay, 2001). Although this model was originally adapted for distance education, it can be easily adapted for campus-based teaching with technology.

**The SECTIONS Model**

We plan to build on the ACTIONS model, but we need to amend it slightly to take into account two factors. It was originally developed for distance education, so it is not surprising that the first criterion is access. The whole point of distance education is to reach students who cannot attend conventional classes, so the technology must be able to reach the target group.
Although access to appropriate technology is also relevant to students in conventional campus-based universities and colleges, it is only one of several student factors that need to be taken into consideration when designing courses. In particular, it is important to consider the range of students being targeted in the course or program: distance learners as well as campus students, undergraduate or graduate students, high school drop outs or lifelong learners, computer literate or technologically naive. We also need to look at differences in learning styles and more generally at individual differences between students as part of the course design process. Hence we need a student criterion for media and technology selection and use.

Furthermore, the original ACTIONS model included ease of use with interaction. But ease of use is a clearly different criterion than the nature of the interaction that the technology facilitates. Indeed, ease of use is in itself a critical criterion: if the technology is difficult to use, is unreliable, or needs high maintenance, the majority of teachers will not use it, and it will interfere with student learning. We believe that the issue of technological comfort as expressed by ease of use is deserving of a category of its own.

We are therefore amending the ACTIONS model to the SECTIONS model, as follows:

S Students: what is known about the students—or potential students—and the appropriateness of the technology for this particular group or range of students?

E Ease of use and reliability: how easy is it for both teachers and students to use? How reliable and well tested is the technology?

C Costs: what is the cost structure of each technology? What is the unit cost per learner?

T 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?

I Interactivity: what kind of interaction does this technology enable?

O 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?

N Novelty: how new is this technology?
S Speed: how quickly can courses be mounted with this technology? How quickly can materials be changed?

Access is thus subsumed under students, ease of use is added as a new criterion, and the rest of the model remains unchanged.

Levels of Decision Making

There are several levels of decision making with respect to choice of media and technologies. At the first level of decision making, strategic decisions may be made by the institution, and tactical decisions made by the individual teacher. If an institution has decided, for instance, to deliver all courses online or to support a particular course development platform such as Blackboard, the individual teacher’s choice of technology will be more limited. But if no strategic decisions have been made by the institution, the teacher has a much wider range of choice but may not have much institutional support once that choice has been made.

The second level of decision is what media to use within a particular technology. For instance, if the decision is made to deliver materials online, decisions still need to be made about when to use video, audio, graphics, and text.

The SECTIONS model can be used to facilitate decisions with regard to choice of technology at both the strategic and the tactical level and also to help decide within a particular technology the most appropriate balance between different media. However, whether or not this particular model is used, teachers or educational administrators making decisions about educational technology should have some theoretical model or framework that guides the choice of media and technology. If not, they will be constantly driven by the latest technology developments, whether or not they are appropriate.

S Is for Students

At least three issues related to students need to be considered when choosing media and technology: student demographics, access, and differences in how students learn.
Student Demographics

We saw in Chapter One that one of the fundamental changes resulting from mass higher education is that university and college teachers must now teach an increasingly diverse student population. This increasing diversity presents major challenges for post-secondary teachers. It requires that courses be developed with a variety of teaching approaches and ways to learn if all students in the course are to be taught well.

In particular, it is important to be clear about the needs of target groups. First and second year students straight from high school are likely to require more support and help studying at a university or college level. They are likely to be less independent as learners, and therefore it may be dangerous to expect them to be able to study entirely through the use of technology. Therefore, technology may be useful as a support for classroom teaching, especially if it provides an alternative approach to learning from face-to-face teaching.

For students who have already been through higher education as a campus student but are now in the workforce, a program delivered entirely by technology at a distance is likely to be attractive. Such students will have already developed successful study skills, will have their own community and family life, and will welcome the flexibility of studying this way.

Third and fourth year undergraduate students may appreciate a mix of classroom-based and distance education courses, especially if some of their face-to-face classes are closed to further enrollments or if students are working part-time to help cover some of the costs of being at college.

Access

Of all the criteria in determining choice of technology, access is perhaps the most discriminating. No matter how powerful in educational terms a particular technology may be, if students cannot access it in a convenient and affordable manner they cannot learn from it. You may believe that video streaming is the best way to get your great lectures to students off campus, but if they do not have Internet access at home or if it takes four hours to download, then forget it.
If you are intending to use computers for students who are on campus, you need answers to a number of questions. What is your or your department's policy with regard to students' access to a computer? Is it optional or obligatory? Will the department provide the necessary access through an on-campus computer laboratory, or do the students have to provide their own computer access? If computers are provided on campus, will there be enough, or will students have to queue? Is the network adequate to support any extra students your class might add? Who else in the university needs to know that you are requiring students to use computers in a lab?

If students are expected to provide their own computers, what type of computer do they need: one at home with Internet access or a portable that they can bring onto campus? What kind of applications will they need to run on their computer? Will they be able to use the same computer and software across all courses, or will they need different software and computers for different courses? What software skills will they need? Will they need to know how to use a particular software before taking a course, or will they be taught this during the course?

Students need to know the answers to these questions before they enroll in a course or program. In order to answer these questions, you and your department must know what students will use their computers for. There is no point in requiring students to go to the expense of purchasing a laptop computer if the work they are required to do on it is optional or trivial. This means some advance planning on your part. What are the educational advantages that you see in students' use of computers? What will students need to do on a computer in your course? Is it really essential for them to use a computer in these ways, or could they easily manage without a computer? What computer skills will they need, and will most students have these skills?

Some institutions, such as Sonoma State University in California, the University of Minnesota at Crookston, Acadia University in Nova Scotia, and Collège Boréal in Ontario, have required all students to have a computer for their programs. However, all four of these institutions spent up to two years on curriculum planning before implementing a university- or collegewide program based on computers. When the students came to class, the benefits of
having a computer were obvious, because the instructors had exploited the technology and were prepared to teach with it. As the use of computers in the classroom grows, it will become more and more important to establish departmental policies regarding students’ access to computers.

The answer to the questions of access, and choice of technology, will also depend somewhat on the mandate of the institution and your personal educational goals. For instance, at the University of British Columbia (UBC) over 95 percent of students already have a computer at home before entering the university. Because it is a highly selective university it can require students to have a computer and can help the relatively few students who cannot afford a computer to purchase one through financial aid.

If the mandate of the institution is to reach learners denied access to conventional institutions, such as the unemployed, the working poor, or workers needing upgrading or more advanced education and training, it becomes critical to find out what technology they have access to or are willing to use.

For instance, the McGill University Health Centre in Montreal conducted a study on how best to improve the communication of health information and education for hard-to-reach patients. These patients or clients were defined as those with low levels of literacy, those who face language and cultural barriers, and those who have difficulties processing information because of physical or cognitive disabilities.

The study found that most of these patients do not, and do not want to, use computers, even though many Canadian hospitals and health care centers are increasingly relying on computer-mediated information systems for patients (Centre for Literacy, 2001). If an institution’s policy is open access to anyone who wants to take its courses, the availability of equipment already in the home (usually purchased for entertainment purposes) becomes of paramount importance. Television, radio, telephones, and print are technologies accessible in nearly all homes in the United States and Canada.

If students do not have access to technology at home, alternatives are to provide the necessary equipment on campus or through access at local community centers or the workplace. Local community centers can be of two kinds: those established specifically and mainly for the use of open and distance learners, and
those in existing colleges or schools where facilities or at least rooms are shared between distance and open learners and campus-based students. Naidoo (2001) provides an extensive discussion of the value of local centers for technology access for students in developing countries.

However, the use of local centers may limit another important factor with regard to access, and that is flexibility. If students have to travel to a local center or if the center is open only at certain times, flexibility will be reduced and the barriers to learning increased.

Finally, one should be careful in making assumptions about student access to computer technology. We will need to know not just whether students have a computer and Internet access at home, but also whether they have high-speed access through (A)DSL or cable or mobile access. Access can change very rapidly. For instance, the percentage of Internet users in Canada who were women went from 27 to 51 percent in less than twelve months between 1997 and 1998. University professors in particular tend to underestimate students' access to advanced technologies (professors are often late adopters of new technology), so always try to find up-to-date information on access if you can.

Student Differences with Respect to Learning with Technologies

It may seem obvious that students will have different preferences for various kinds of technology or media. The design of teaching should cater to these differences. Hence if students are visual learners, they should be provided with diagrams and illustrations. If they are auditory learners, they will prefer lectures and audio-cassettes. Identifying dominant learning styles should then provide strong criteria for selecting media and technology.

McLoughlin (1999), in a thoughtful review of the implications of the research literature on learning styles for the design of instructional material, concluded that instruction could be designed to accommodate differences in both cognitive-perceptual learning styles and Kolb's (1984) experiential learning cycle. In a study of new intakes conducted over several years at the University of Missouri-Columbia, using the Myers-Briggs inventory, Schroeder
A FRAMEWORK FOR SELECTING AND USING TECHNOLOGY

(1993) found that new students think concretely and are uncomfortable with abstract ideas and ambiguity.

However, a major function of a university education is to develop skills in abstract thinking and help students deal with complexity and uncertainty. Perry (1970) has shown that learning in higher education is a developmental process. It is not surprising then that many students enter without such skills. Indeed, there are major problems in trying to apply learning styles and other methods of classifying learner differences to media and technology selection and use.

Laurillard (1993) makes the point that looking at learning styles in the abstract is not helpful. Learning has to be viewed in context. Thinking skills in one subject do not necessarily transfer well to another subject. Some ways of thinking are specific to different subject areas. Hence, logical-rational thinkers in the sciences do not necessarily make thoughtful husbands or good literary critics. Part of a university education is to understand and possibly challenge predominant modes of thinking in a subject area. Although we believe in learner-centered teaching, students still need to understand the inherent logic, standards, and values of a subject. They also need to be challenged and encouraged to think outside the box.

Finally, the research on the effectiveness of matching instructional method to learning styles is at best equivocal. Steven Stahl (1999), in a particularly scathing critique of learning styles, writes: “The reason researchers roll their eyes at learning styles is the utter failure to find that assessing children’s learning styles and matching to instructional methods has any effect on their learning.”

This comment is reinforced in a study by Dziuban, Moskal, and Dziuban (2000). They applied Long’s reactive behavior analysis of learning styles to students in both face-to-face classes and Web-based online classes. They found that learning style did not appear to be a predictor of who withdraws from Web courses, nor were independent learners likely to do better online than other kinds of learners.

The limitations of learning styles as a guide to designing courses does not mean that we should ignore student differences. We should certainly start from where the student is. In particular, we need strategies to gradually move students from concrete learning
based on personal experience to abstract, reflective learning that they can then apply to new contexts and situations. We shall see that technology can be particularly helpful for that.

We need to ensure when designing courses that we offer more than one approach to teaching and learning within the same course. For instance, we need to ensure that there is well-structured, relevant information easily available to students, but also that there are opportunities for students to seek out new or different information. This information should be available in a variety of media, such as text, diagrams, and video, with concrete examples explicitly related to underlying principles. Creating a range of materials in different media may be more expensive initially, but once created they can be used with a wide range of students over time.

When using technology for teaching, there should also be a range of learner activities available, such as researching readings on the Web, online discussion forums, synchronous presentations, assignments, and online group work. These activities should be integrated and coordinated and in particular need to relate directly to assessment processes. The range of activities increases the likelihood that a variety of learner preferences are being met, and also encourages learners to involve themselves in activities and approaches to learning in which they may initially feel less comfortable. (In Chapter Nine we will discuss how the online group process can be structured to help such students.)

Such approaches to design are more likely to be effective than courses in multiple versions developed to meet different learning styles. In any case, developing multiple versions of courses for different styles of learning is likely to be impractical in most cases.

Questions for Consideration

It is critical to know your students. In particular, you need the following information to provide an appropriate context for decisions about media and technology:

1. What is the mandate or policy of your institution, department, or program with respect to access?
2. What are the likely demographics of the students you will be teaching? How appropriate is the technology for these students?
3. If your students are to be taught at least partly off campus, to which technologies are they likely to have convenient and regular access at home or work?
4. If they are to be taught at least partly on campus, what is—or should be—your or your department’s policy with regard to students’ access to a computer?
5. What computer skills do you expect your students to have before they start the program?
6. If students are expected to provide their own access to technology, will you be able to provide unique teaching experiences that will justify the purchase or use of such technology?
7. What prior approaches to learning are the students likely to bring to your program? How suitable are such prior approaches to learning likely to be to the way you need to teach the course? How could technology be used to cater to student differences in learning?

There are many different ways to get the information needed to answer these questions. In many cases, you will still have to make decisions with insufficient evidence, but the more accurate the information you have about your potential students, the better your choice of media and technology is likely to be. Almost certainly, though, you will have diverse students, so the design of your teaching will need to accommodate this fact.

**E Is for Ease of Use**

The use of technology in teaching is generally a means, not an end. Therefore, it is important that students and teachers not spend a great deal of time on learning how to use educational technologies or on making the technologies work. The exceptions of course are when technology is the area of study, such as computer science or engineering, or when learning the use of software tools is critical for some aspects of the curriculum; for instance, computer-aided design in architecture, spreadsheets in business studies, and editing software in video production. In most
cases, though, the aim of the study is not to learn how to use a particu-
lar piece of educational technology, but the study of history, mathemat-
ics, or biology.

Computer and Information Literacy

If a great deal of time has to be spent by the students and teachers in learning how to use software for the development or delivery of course material, for instance, this distracts from the learning and teaching. Of course, there is a basic set of literacy skills that will be required, such as the ability to read and write, use a keyboard, use word processing software, navigate the Internet, and use Internet software. These generic skills, though, could be considered pre-
requisites. If students have not adequately developed these skills in school, an institution might provide preparatory courses for students on these topics. For instance, at UBC, the library provides students with help in using and navigating the Internet.

Orientation

In the distance education unit at UBC, one of the standards or cri-
teria for the selection of course software is that novice students (that is, students who have never used the software before) should be studying within twenty minutes of logging on. The twenty minutes may be needed to work out some of the key functions of the software that may be unfamiliar or work out how the course Web site is organ-
ized and navigated. But twenty minutes is more of an orientation period than time for learning new skills of computing. If we do need to introduce new software that may take a little time to learn, for instance, a synchronous chat facility or video streaming, we will try to do this at the point it is needed. It is important to provide time within the course for the students to learn any such new skills.

Interface Design

The critical factor in making technology transparent is the design of the interface between the user and the machine. An educational program or indeed any Web site should be well structured, intu-
itive for the user to use, and easy to navigate.
Interface design is a highly skilled profession, and is based on a combination of scientific research into how humans learn, an understanding of how operating software works, and good training in graphic design.

The current general interface of computers—a keyboard, mouse, graphic user interface of windows, pull-down menus, and pop-up instructions—is still extremely crude and not compatible with most people's preferences for processing information. Therefore, a great deal of effort has to go into the design of material appearing on a computer screen to make it easy to use. The Web is just as much a prisoner of the general computer interface as any other software environment, and the educational potential of any Web site is also restricted by its algorithmic or tree-like structure.

Hence the general interface of computers is very limiting for educational purposes. It places very heavy emphasis on literacy skills and a preference for visual learning. This causes major problems for students with certain disabilities, such as dyslexia or poor eyesight, and the tree-like structure of a Web site also provides some educational limitations. For instance, it does not always suit the inherent structure of some subjects or the preferred way of learning of some students.

There are several consequences of these interface limitations for teachers in higher education. The first is that it is really important to choose teaching software or other technologies that are intuitively easy to use for the students in particular but also for the teacher in creating materials and interacting with students.

Second, when creating materials for teaching the teacher needs to be aware of the issues concerning navigation of the materials and screen layout and graphics. Although it is possible to add stimulating features such as audio and animated graphics, these features come at the cost of bandwidth. Such features should be added only when they serve a useful educational function, as slow delivery of materials is extremely frustrating for learners, who will normally have slower Internet access than that of the teacher who is creating the materials. Given that the design of Web materials requires a high level of specialized skill, it is preferable to seek a specialist's help.

Third, we can expect in the next few years some significant changes in the general computer interface with the development
of speech recognition technology and the use of kinesthetics (for example, hand movement) to control the computer. Changes in basic computer interface design could have as profound an impact on the use of technology in teaching as the Internet. Given the rapid rate of change in the technology, it would be wise to not invest too much time and effort in a particular technology unless the materials can easily be moved into a new technology environment.

Reliability

The reliability and robustness of the technology is also critical. Most of us will have had the frustration of losing work when our word processing software crashes. The last thing you want as a teacher is lots of calls from students saying that they cannot get the program to work, or that their computer keeps crashing (if the software locks up one machine, it will probably lock up all the others!). Technical support can be a huge cost, not just in paying technical staff to deal with service calls, but also in lost time of students and teachers.

This means that you do not want to be at the leading edge in your choice of technology if it is to be used in any significant and regular form of teaching. For instance, although WebCT was developed at UBC, the distance education unit waited a year until it had been fully field-tested before adopting it. With over sixty online courses and five thousand students to support, we could not afford to have major software problems. It is wise then not to rush in and buy the latest software update or new product—wait for the bugs to be ironed out. Finally, unless you are a well-trained and experienced computer programmer with substantial capital investment opportunities behind you, you should avoid developing your own software for teaching or using software developed by colleagues within the university. This could easily become a black hole as far as your time is concerned.

A feature of online learning is that peak use tends to fall outside normal office hours. Therefore, it is really important that your course materials sit on a reliable server with high-speed access and twenty-four-hour, seven-days-a-week reliability. In our distance education unit, we have a dual server that provides automatic backup, so that if one server area goes down we can continue service in the
other server area. Ideally, the server should be in a secure area (with, for instance, emergency electricity supply) with twenty-four-hour technical support, which probably means locating your server with central information technology (IT) services. If your department is offering several courses over the Internet, you will probably need your own Webmaster, who can ensure that course materials are properly maintained and organized on the Web site and who can handle basic maintenance of the server.

However, the good news is that most commercial educational software products, such as WebCT and Blackboard, and servers are very reliable. We receive very few calls from our students on technical matters, and when we do, they are usually problems specific to the student’s own computer or Internet service provider. The main technical issue we face is software upgrades. This means moving course materials from one version of the software to the new version. This can be costly and time-consuming, particularly if the new version is substantially different from the previous version.

Questions for Consideration

Some of the questions that you need to consider are

1. How intuitively easy to use is the technology by both students and teachers?
2. How reliable is the technology?
3. How easy is it to maintain and upgrade the technology?
4. Is the company that is providing the critical hardware or software you are using a stable company that is not likely to go out of business in the next year or two, or is it a new start-up?
5. Do you have adequate technical and professional support, both in terms of the technology and with respect to the design of materials?

In summary, ease of use requires professionally designed commercial course software, specialized help in graphics, navigation and screen design for your course materials, and strong technical support for server management and maintenance. Without such professional support, a great deal of your time as a teacher will be
spent on technical issues, and to be blunt, if you do not have easy and convenient access to such support, we would strongly advise you not to get heavily committed to technology-based teaching.

**C Is for Costs**

A proper understanding and analysis of costs is essential for making sensible decisions about the use of technology in education. This is a very large topic and has been dealt with more extensively elsewhere (see for instance Bates, 2000; Rumble, 1997; Finkelstein et al., 2000; Jones, 2001; and Boeke, 2001). In this chapter, we will focus on the cost factors that the regular university or college teacher needs to consider when choosing or using technology for teaching.

**Cost Factors: Items of Expenditure**

There are two sets of cost factors to be considered: individual items of expenditure and the drivers of costs.

Starting with individual items of expenditure, there is first the cost of purchasing or licensing equipment or software. Sometimes equipment is considered a free or zero teaching cost. For instance, if a central service has purchased videoconferencing or server equipment and has provided technical staff to support the use of the technology, managers may decide to make these services available free of charge to teaching units to encourage their use and hence justify the central investment already made. For instance, an institution may decide to buy centrally a site license for computer software. Provided the institution as a whole does not exceed the agreed number of students permitted to use the software, there is no apparent cost to a teaching department for the use of that software. Nevertheless, there is a cost to the institution overall, although individual teachers may not need to worry about that.

A second item that cannot be avoided is the cost of copyright clearance and permissions. Copyright and intellectual property is a major issue that will be dealt with in more detail in Chapter Eight. Note that there are two costs associated with copyright clearance: the cost of royalty payments, which often is not substantial or may be granted free for educational use; and the cost involved
in tracking down the copyright holder and obtaining permission, which can be a major cost in time. Again, some institutions will provide a central copyright clearance service, but in many cases the individual teacher will need to clear copyright.

Other costs might include photocopying or printing of materials for students, such as handouts or articles. Indeed, departmental photocopying costs can be reduced substantially by making materials available instead on the Web, although this may be merely transferring printing costs from the department to the students.

Another cost will be the time of specialists who help with the development and delivery of the course material. There may be costs for a graduate student or Web programmer who transfers Word documents or sketches into a Web format. There may also be costs for additional contract instructors or adjuncts who help with the delivery of the program.

The major cost though of any technology-based teaching will be the time of the teacher or subject expert. Most teachers who develop their own online material and teach online complain that this is a great deal more work than face-to-face teaching. This is true if teachers have no technical help and work independently. Unfortunately, the time of academics is often treated as "free" once salaries have been paid. If teachers choose to spend more time preparing technology-based materials it may not be seen as a cost either by the teacher or the institutional management. However, there is a real cost in lost research time, public service, or institutional administration.

The intelligent use of technology for teaching need not lead to more work for the teacher, but only if the teacher works in a different way and in particular only if the teacher works as part of a team of professionals. This issue is discussed in more detail in Chapter Six.

Cost Factors: Drivers of Costs

The primary factors that drive cost are the production of materials, the delivery of materials, and the number of students.

Production of technology-based materials such as a video program or a Web site is a fixed cost in that it is not influenced by how many students take the course. However, production costs can vary
depending on the design of the course. Hence a Web site that requires a great deal of original graphics or multimedia material, Java programming for student interaction, or the development of simulations or games will cost a lot more than a simple Web site directing students to online or printed readings. Nevertheless, once produced the cost is independent of the number of students. Therefore, the more expensive the course to develop, the greater the pressure to increase student numbers to reduce the average cost per student. There are opportunities for economies of scale, provided that student course enrollments can be increased (which may not be the case).

Similarly, there are costs in teaching the course once the course is developed. These tend to be variable costs in that they increase as class size increases. If student-teacher interaction, through online discussion forums and assignment marking, is to be kept to a manageable level, the teacher-student ratio needs to be kept relatively low (for instance 1:25). The more students, the more time a teacher will need to spend on delivery, or additional contract instructors will need to be hired. Either way, increased student numbers will lead to increased costs.

There may be benefits for a teacher or an institution in spending more money up front for interactive learning materials if this leads to less demand for teacher-student interaction. For instance, a mathematics course might be able to use automated testing and feedback, simulations and diagrams, and pre-designed answers to frequently asked questions with less time spent on individual assignment marking or communication with the teacher. Alternatively, in subjects that depend on a great deal of discussion and personal interaction with the teacher, such as women's studies, it might be better to have a simple Web site with lots of printed readings but a relatively low teacher-student ratio. For this reason, we now cost our distance courses over a five-year period. In this way we can vary the costs of development and delivery while still maintaining a stable average cost per student over time.

Cost is generally a good discriminator in media and technology selection and use. Costs vary a great deal between different media in particular. Audio is relatively cheap to produce and distribute; video is relatively expensive. Good quality educational print material is relatively expensive to produce but cheap to distribute.
Online courses are relatively cost-effective for class enrollments of between twenty to a hundred if enough suitable additional contract instructors can be found. However, online courses become expensive compared to face-to-face teaching if numbers drop below twenty students per course offering, and expensive compared to print-based distance education if numbers exceed a hundred per course offering.

Questions for Consideration

In deciding on media or technology use, the following questions need to be answered:

1. What media must be included to ensure that the learning goals are reached?
2. How much will it cost to develop materials in this medium or technology (including the time of the teacher)?
3. How many students are likely to take each course offering? What will be the teacher-student ratio?
4. What will it cost to deliver the course by using a particular technology (including the time of the professor or contracted instructors) while maintaining a high quality of interaction?
5. What will be the average cost per student over a five-year period and how will this compare to the cost of using other media or technologies (including face-to-face teaching)?

T Is for Teaching and Learning

It might be thought that effectiveness of teaching and learning should be the first criterion to be considered. If the technology is not effective educationally, it should not be used no matter how cheap or easy to use it is. However, it is much easier to discriminate between media and technologies on the basis of student access, ease of use, or cost than it is on the basis of teaching effectiveness. Therefore, the previous criteria are better discriminators than teaching and learning.

Teaching and learning factors are less accurate as a discriminator because teachers, learners, and media are all very flexible. For instance, if motivation and skill are strong enough, teachers
can teach well and students can learn well from most media and technologies. This does not mean that there are not some teaching and learning advantages of some media and technologies over others. These advantages are linked to the following aspects of teaching: epistemology, the content and the skills to be developed by the learner, and methods of student assessment.

Epistemology and Selection of Technology

There are bound to be assumptions about the learning process embedded within any decision about the use of technology in education and training. We described these assumptions in Chapter Two, in particular assumptions about the nature of knowledge, learning, and teaching. The assumptions will influence to some extent the choice and particularly the use of media and technology.

For instance, if the teaching is to focus on transmission of information, what will be required are the comprehension of facts, theories, and principles; accurate reproduction of that learning; followed by the clear, sequential presentation of information, tests, and immediate feedback. Several media—video, graphics, text—could be used for clear presentation, depending on the nature of the subject. In geology heavy emphasis might be made of color graphics; in engineering, animation; and in logic or law, text. Computing can provide testing and immediate feedback.

If the emphasis is on interpretation or analysis of “real” situations and the application of knowledge to new contexts, then media and technologies that accurately reflect the real world but allow for interpretation and analysis might be used. Video is likely to be a particularly useful medium in this context for presenting “cases.” However, analysis of the case might depend on audio or text if the skill is to be directly taught. If there are possibilities for multiple interpretations, some form of online discussion between students may be necessary as a supplement.

If the emphasis is on learners’ drawing on previous knowledge and the experience of others and creating new meanings or knowledge through dialogue and discussion, then priority may be given to online discussion forums.

Of course, all these approaches may be valuable at different times within the same course. However, it is important to ensure
that the choice and use of technology enables or facilitates the particular approach to teaching and learning required by instructors and learners at a particular point in the teaching. It is especially important not to choose one particular technology and then try to force all forms of teaching into that one technology.

Content and Skills

When making decisions about media and technology use, it is also useful to make a distinction between content and skills. Olson and Bruner (1974) argued that learning involves two distinct aspects: first, acquiring knowledge of facts, principles, ideas, concepts, events, relationships, rules, and laws; and second, using or working on that knowledge to develop skills.

Every content area has its own presentational and skill requirements. For instance, philosophy is well served by printed text that can be considered and reflected upon and by dialogue and argument. Chemistry requires large numbers of diagrams, animations, and formulae and heavy use of color. On the skill side, it requires analytic and experimental skills. History requires access to text and media archives, analytical skills, and strong writing skills. Different media in particular can facilitate the presentation of different kinds of content and can facilitate different skills. Part of the art of course design is to match those requirements.

Student Assessment Strategies

A third consideration, very closely linked to skills, is the best form of evaluating or assessing students in a particular subject area. The form of assessment should match the skills being taught. For instance, if the aim is to identify and treat a medical problem, multiple choice paper-and-pencil tests of comprehension of facts are likely to be inappropriate. Setting a problem for solution would be more appropriate. If media and technology are being used to teach skills, it may be necessary to use media and technology to assess those skills, or rather, a particular medium or technology may provide a better test of a particular skill than other technologies.

It is important that a teacher is clear about what kinds of learning or approaches to learning are preferred. The teacher also
needs to be clear about the presentational requirements of the subject and the skills that need to be developed or enhanced during the course. Teachers should also consider the potential of media and technologies for presenting desirable content or developing useful skills that may otherwise have been difficult to present in a classroom situation.

Also important are the representational requirements and the structure and organization of the subject matter, which were discussed in Chapter Three (see under Media, Technology, and the Representation of Knowledge).

We shall see in the next chapter that the professional input of an instructional or curriculum designer can be very helpful for this kind of exercise. However, by considering the content and skills requirements of a course, along with the potential match of media and technologies to those requirements, a teacher is more likely to exploit the full potential of media and technology.

Questions for Consideration

In order to make the best possible decisions about the choice and use of media and technology for teaching and learning purposes, the following questions need to be answered.

For any given context

1. What is the preferred approach to teaching in terms of your views about the nature of knowledge, teaching, and learning?
2. What are the presentational requirements of the content of this course? Which media or technology will best facilitate these presentational requirements?
3. What skills need to be developed during this course? Which media or technologies will best facilitate the development of these skills?
4. What media or technologies will best assess these skills?

I Is for Interaction and Interactivity

Most theories of learning suggest that for learning to be effective it needs to be active; in other words, the learner must respond in some way to the learning material. It is not enough merely to listen, view, or read; learners have to do something with the learning
material. Thus they may need to demonstrate (if only to themselves) that they have understood, or modify their prior knowledge to accommodate new information, or analyze new information in light of their existing knowledge.

Feedback is considered an important component of interaction. Feedback provides learners with knowledge of results that indicates whether they have learned correctly. Feedback can be very simple, merely providing correct answers to straightforward questions, or it can be much more complex, suggesting a variety of alternative responses and ways to evaluate among them.

Technologies differ considerably in how they encourage interaction. Many arguments about the value of technology in education, and the extent to which it can or should replace face-to-face or human interaction, are often based on confusion and misunderstanding about the contexts in which interaction takes place.

There are two rather different contexts for interaction. The first is an individual, isolated activity, and that is the interaction of a learner with the learning material, be it text, television, or computer program. The second is a social activity, and that is the interaction between two or more people about the learning material. Both kinds of interactions are important in learning, and both kinds of interactions can be differentially facilitated by various technologies.

Interaction Between Learners and Learning Materials

Although on conventional campuses a great deal of consideration is given to classroom teaching and interaction with students, in reality by far the largest part of studying in higher education is done alone by the student while interacting with textbooks or other learning media. As students on conventional campuses move more and more to technology-based learning, this fact needs to be acknowledged in the design of the learning materials. This means building opportunities for explicit interaction within the learning materials through the use of exercises, activities, tests, and feedback.

Learning as a Social Activity

Particularly in higher education, high value is often placed on academic discourse, that is, developing student skills of analysis, constructing and defending an argument, assembling evidence in
support of an argument, and critiquing the work of scholars and fellow learners. Many professors consider that the skills of academic discourse are best learned through small group discussions led by an experienced academic (Plato's Socratic Method). Although technology may not be able to replace learning as a social activity, it can facilitate it.

Social interaction may be of three types in technology-based learning:

- Interaction between the learner and the originator of the teaching material
- Interaction between the learner and an instructor who mediates between the original material and the learner by providing guidance or assessment
- Interaction between the learner and other learners

Note that in all three types, interaction can take place without face-to-face contact; in other words, even interpersonal interaction can be at a distance, for instance via the mail or through technologies such as the telephone or computer-based electronic mail.

In the area of social interaction, then, we need to differentiate between interaction that is remote or face-to-face and also between interaction that is in real time or asynchronous.

In other words, social interaction is not necessarily time or place dependent or even dependent on the creator of learning materials if mediating instructors or peer groups are used. Technology now allows us, as we saw in Chapter Three, to provide interaction synchronously or asynchronously, with or without participation by the originator of the teaching material. We need to assess which type of interaction will best suit our needs in our teaching and which media or technology will best provide that type of interaction.

The Quality of Interaction

It is very simplistic to think that a technology such as computing is automatically more interactive than one such as television, just because computers force a learner response while television appears to be a passive medium. The quality of the interaction and feedback is critical. Much of the most useful interaction between
A FRAMEWORK FOR SELECTING AND USING TECHNOLOGY

a learner and the learning material is covert—perhaps best described as thinking. A well-written book or stimulating television program may well encourage a high level of interaction in the learner, without any apparent overt actions. Similarly, learners can easily find ways to "beat" a computer, not by thoughtfully responding to its questions but by second-guessing the pattern of predetermined, multiple-choice answers or by random guessing until the correct answer is found.

One way of evaluating a technology's capacity for feedback is to examine the extent to which it provides flexibility for dealing with the learner's response to activities. For instance:

- Does it provide merely "yes or no" information as to whether the learner has responded correctly?
- Does it provide remedial activities—for example, further information or reading—if the answer is not rated correct or adequate?
- Does it engage the learner in some form of discussion or dialogue about the quality of the learner's response? For instance, does it allow the learner to develop or test an argument or a pattern of thinking? Can it provide adequate feedback on the learner's response?
- How does it handle an original response not anticipated by the instructor or learning material?

As we move down this list of questions, the quality of interaction will be less easily provided by the machine and more easily handled by the intervention of a teacher or instructor or by interaction between students.

Finally, a feature of teaching with technology is the ability to separate the process of creating learning materials from the process of mediating learning. For instance, subject experts such as professors may create material, but the process of learning may be mediated through another person. The term in North America for the person who acts in this mediation role is instructor, although we prefer the British word tutor, which reflects better the facilitating rather than the instructional role. The tutor or instructor may not have created the original material but may be skilled in helping students with the process of learning.
Indeed, this mediating role is not a new phenomenon. Ever since the creation of textbooks, university professors and secondary school teachers have mediated the work of other subject experts. Similarly, in classroom teaching at a university, it is now very common to use less qualified, contracted adjunct teachers or graduate students (teaching assistants) to provide help for the regular tenured professor in teaching large classes. Technology does not change this division of labor, but it does make the division of labor less place-and-time dependent and, more important, allows the division of labor to be organized differently than in face-to-face teaching.

In summary, interaction is an essential part of learning. It comes in two distinct forms: interaction between the learner and learning materials, and interaction between the learner and other people, who may be instructors or other students or both.

Questions for Consideration

Questions that need to be asked when selecting or using technology are

1. What kind of activities by the student would most facilitate learning of this subject?
2. What media or technology would best facilitate this interaction?
3. How can technology enable scarce teaching resources to be best used, and be best supported by less scarce resources, with respect to increasing the amount and quality of learner interaction?

Because interaction is so important for learning, this topic will come up again when we look at course design and course delivery.

O Is for Organizational Issues

Again, this is a major topic, dealt with more fully elsewhere (see, for instance, Bates, 2000). We shall see, however, that technology-based teaching needs an effective organizational system to make it feasible and practical.
The presence or absence of organizational support for different technologies is a key factor in technology choice and use. Without appropriate organizational support for technology-based teaching, the workload of university and college teachers becomes impossible. For instance, if teachers have inadequate or no technical support, they will need to deal with all student technical problems, as well as deal with any technical difficulties they might encounter when developing teaching materials. Although professors may be able to start teaching with a new technology for a period short enough to demonstrate its value, it will be difficult or impossible to spread its use across the university without the necessary technical support being put in place.

So if the institution is not supporting the technology you want to use, you need to make a careful decision as to whether you are prepared to make the substantial effort needed to be an innovator in teaching.

Questions for Consideration

Questions to ask in the choice or use of technology with respect to organizational issues are as follows:

1. What can I do easily myself with a particular technology, and what help will I need?
2. Is the technical help I need already available or likely to be provided within existing resources?
3. Does the senior management of the institution support this technology, or is it likely to develop an adequate organizational structure to support this form of teaching with technology?
4. Where can I go for help and support in using this technology for teaching?

N Is for Novelty

Novelty is probably the least important criterion, but one that nevertheless should be taken into consideration. It is in fact a two-edged sword.

It is often easier to win friends and influence people by being an innovator, and it is certainly often easier to obtain grants for
trying out new technology than for improving the use of existing technology in teaching. You need to consider, though, all the extra work that this will entail and whether you are likely to be adequately rewarded for such efforts in your teaching. Indeed, it can be very dangerous to use leading edge technology that has not been fully tested. Major problems for your students may develop if the technology is unreliable or difficult to use. Even if you do wish to be an innovator, it may be more profitable and less time-consuming in the long run to look at new ways of teaching with existing technology, rather than risking untested or partly developed new technologies.

S Is for Speed
Technologies vary in their capacity for speed of implementation and flexibility in updating. One advantage of face-to-face teaching is that it needs relatively little time for advance preparation compared with developing a fully online course, for instance. A Web site is easier to change and update than a printed text.

Questions for Consideration
The questions that need to be asked are as follows:

1. How fast-developing is this subject area? How important is it to regularly change the teaching materials? Which technology will best support this?
2. How easy is it to make changes and how quickly can changes be made with this technology?
3. To what extent can the changes be handed over to someone else to do? How essential is it for me to make the changes myself?

Conclusions
In this chapter we set out a broad framework for the selection and use of media and technology for teaching in higher education. The framework takes the form of a series of questions under a set of headings that need to be answered by teachers who are think-
ing of using technology for teaching. The answers will depend to a large extent on the context in which the teaching is to take place and on the preferences of the teacher.

It is worth pointing out that the process of decision making proposed in this chapter is not mechanical or "scientific." There are many different factors to be taken into account, and the decisions will need to be context specific. In dealing with such complexity, the best approach is to

- Use a framework (for example, SECTIONS) that identifies the main factors to be considered
- Systematically analyze each of the factors by answering a set of relevant questions
- Collect and review all the responses to these questions
- Make an assessment of the resources likely to be available, in particular the time and skills of the teacher
- Make an intuitive or subjective decision about the best mix of media and technologies to use based on the information collected

This process can be used in the initial choice of technologies for a course, program, or institution (strategic) and in making decisions during the actual course design process with respect to appropriate media (tactical). The process primarily sensitizes the teacher to the key factors that need to be taken into consideration in what is usually an ongoing process of decision making during course development and design.

We have now set out the basic fundamentals that need to be considered in the effective use of technology for teaching in higher education. In the rest of this book we will look at the applications of these fundamentals to the process of course design and delivery.