*Chapter Six*

# Calculating the Costs of Teaching with Technology

There are fundamental differences between the cost structures of face-to-face and technology-based teaching. Indeed, cost structures of different technologies, such as videoconferencing, the Web, and CD-ROMS, vary considerably. This means that what may be cost-effective in one context-for example, a course with small annual enrollments-may be very different in another-for example, a course with large annual course enrollments. A basic understanding of the cost structures of technology-based teaching is essential to decision making.

## Technology Costs

The heading has two meanings and both are relevant: first, technology costs lots of money, and second, a variety of costs are associated with the use of information technology at a university or college, some of which tend to be ignored, underestimated, or underbudgeted.

### Analyzing Technology Costs

Technology costs can be broken down into a number of categories, including technology infrastructure, administrative applications, and academic applications.

I am primarily concerned in this book with the third area, the costs of academic applications. However, until quite recently technology investment has been driven primarily by administrative rather than academic requirements. Information systems were originally developed for student registration and records, financial tracking and management, and human resources management. Communications systems such as telephone and e-mail were also developed primarily for management and administrative purposes.

Although there has always been educational technology investment, some of a substantial nature-such as television studios-this has tended to be relatively independent of the main administrative systems. In the last few years, though, the development of the Internet and especially the World Wide Web has led to a considerable increase in the use of computers and networks for academic as well as administrative purposes. These academic applications tend to use the same or similar networks and systems as administrative applications.

This use of existing networks for academic applications has some advantages and some disadvantages. Infrastructure costs can be shared across a wider range of applications. However, as more and more use is made of information systems for educational purposes, capacity issues and conflict over priorities can arise. Administrative systems are primarily concerned with text and number crunching, and are not usually real-time related; in other words, data can be stored and for-warded to even out the traffic. Such systems may not be the best for educational purposes (which tend to be increasingly multimedia and hence real-time dependent).

Also, the true cost of educational applications may be hidden because the time instructors spend developing technology-based educational materials is not tracked or budgeted. Educational technology support costs may be underbudgcted because their importance is not understood or because such costs conflict with other funding priorities, such as research.

Thus, before looking at funding strategies it is important to get a general understanding of the nature of the costs of educational technologies and their relation to benefits.

## Understanding the Human Nature of Cost Analysis

It may not come as a surprise to know that governments, educational institutions, and even the private sector are often prepared to invest many millions of dollars in information and communication technologies without any understanding or appreciation of the relationship between costs and performance. As Holt and Thompson (1998) point out: "It appears that investment in IT in universities is a highly politicized process often based at least partly on an act of faith that IT will help to deliver on the quality and productivity agenda.... Such investment processes and imperatives are not necessarily amenable to rationalistic cost-benefit investment models and techniques."

The lack of willingness of managers, researchers, and governments to develop and apply cost-benefit analysis to technology investment in education is a clear indicator that education is not a technical-rational activity but one in which mystique, prejudice, and ignorance sometimes rule-which is probably why we love it so much.

Yet cost analysis in this field is not rocket science. Compared with understanding human behavior or predicting the weather, cost analysis is relatively simple. Although costs vary from context to context, there is a well-defined underlying structure to technology costs, which enables reasonably accurate cost analyses to be made. Nevertheless, although costing exercises usually apply quantitative techniques, one should not be fooled by the apparent "scientific" nature of this process. All costing exercises depend on making certain assumptions. These assumptions are open to challenge.

Furthermore, costing activities are context-driven. What is treated as a cost in one organization may not be treated as a cost in another. Management can quite arbitrarily decide what constitutes a cost. For instance, in my university, videoconferencing facilities are not charged directly to departments wishing to use these services for teaching, whereas printing costs are.

There are always reasons why things are costed the way they are. The issue is whether they are good reasons. Furthermore, whether they are good reasons will depend on who you are and what decisions you have to make. The manager of a videoconferencing unit trying to keep staff fully employed and the facilities heavily used would not want to load all costs on to users, especially those costs (for example, salaries of regular staff) that have to be met whether or not the facility is used. In contrast, the vice president of information systems, who as a result of a university policy decision has to pay for all services from fees charged to users, may have a difference of opinion with the videoconferencing manager over his charging policy.

Note also in this case that the vice president of information systems may be enforcing a policy she does not agree with but which has been made at an even more senior management level. You are then right into the politics of an organization and the consistency or logic (or lack of it) in setting budgets and allocating costs. For instance, why in some institutions are information technology costs recharged to academic departments when library costs are not?

One answer may be that library costs are considered a core academic function, while the institution has not yet in practice accepted information technology as having the same status.

All this is just another way of saying that it is important to think critically and analytically about the following costing methods and their application, because you may quite legitimately want to analyze costs using completely different assumptions.

## Calculating the Costs of Teaching with Technology

This is a very brief introduction to a quite complex area (see Bates, 1995, and Rumble, 1997, for more information on costing methods). However, an understanding of key principles of costing new technologies for teaching is essential for decision making.

The most important distinction is between fixed *and variable* costs. Fixed costs do not change with student numbers, while variable costs do. One element of fixed costs is the cost of developing materials. Once a CD-ROM is designed and finished, that *develop*ment cost is fixed, no matter how many students subsequently use it. However, the cost of *distributing* a CD-ROM is variable, because the more students, the more copies need to be made, and hence the higher the cost of duplication and distribution.

The costs of technology-based teaching differ fundamentally from the costs of face-to-face teaching in terms of the ratio of fixed to variable costs. In the conventional higher education model, costs have tended to increase with student numbers, or quality drops. In other words, if the student-teacher ratio is kept constant, more teachers are needed. If more teachers are not recruited, class size increases, interaction with the teacher drops, and quality declines.

Figure 6.1 shows the relationship between costs and student numbers for conventional classroom teaching with levels of teacher-student interaction kept constant. Costs increase as a step function. If the "target" teacher-student ratio is 1:20, then costs increase with each twenty students as an extra teacher is hired.

However, the cost structures for technology-based teaching are quite different. Technology-based courses cost a good deal of money up front to create, but once created many students can use them with relatively small increases in costs. Thus their fixed costs are high but their variable costs are low, in comparison with face-to-face teaching.

Figure 6.2 shows the relationship between the costs of classroom teaching and the costs of preprepared multimedia materials, such as a CD-ROM or a Web site.

Original multimedia materials such as a CD-ROM created from scratch have a higher "starting" or fixed cost than classroom teaching, but after production the only additional costs are those of making and distributing compact discs (assuming that students already have their own computers and CD-ROM players).

Still, Figure 6.2 does not cover all the costs of technology-based teaching. Well-designed multimedia materials can both present information and provide a large amount of the interaction and feedback that would otherwise be provided by teachers. This frees up time for the teacher to concentrate just on those areas where person-to-person interaction is critical.

**Figure 6.1. Costs of Classroom Teaching.**

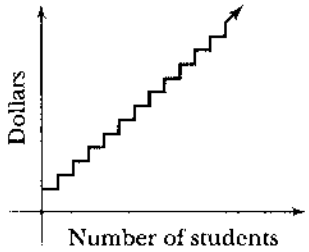
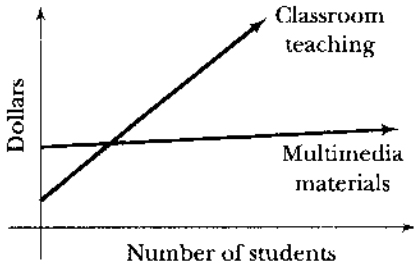
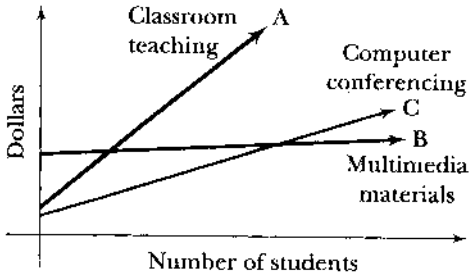



**Figure 6.2. Costs of Classroom Teaching Versus Multimedia Materials.**




Computers are not smart enough, however, to anticipate all the questions, misunderstandings, and more important, original and creative outputs that students can generate. Thus, there is still the need for some provision not only for student-teacher interaction but also even more important for interaction between students. In the traditional face-to-face context this interaction is provided through small-group seminars. The equivalent in technology-based teaching is on-line discussion forums, such as computer conferencing. Thus, we have to consider not only the cost of preprepared multimedia materials but also the cost of on4ine discussion and tutoring, as shown in Figure 6.3.

**Figure 6.3. Costs of Computer Conferencing.**

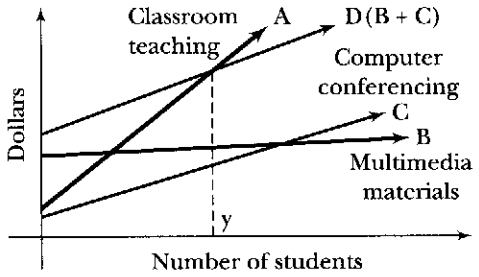


This figure indicates the cost of providing on-line student-teacher and student-student interaction (via computer conferencing, Arrow C). The costs of on4ine interaction tend to be lower than those of conventional teaching as student numbers increase. This is because a good deal of the students' study time with technology-based learning is spent interacting with the preprepared multimedia material, so the teacher needs to spend less time per student overall moderating discussion forums compared with the total time spent in classroom teaching. However, the on-line costs still have to be added to the costs of preprepared multimedia materials, as shown in Figure 6.4 (Arrow D).

It can be seen in this model that for smaller numbers of students, conventional classroom teaching is likely to be less costly than preprepared multimedia and computer conferencing combined. However, as numbers increase the new media become increasingly more cost-effective.

The question on everyone's lips is: "What is the number of students at which technology-based teaching becomes more cost-effective than face-to-face teaching (point y in Figure 6.4)?" The unsatisfactory answer is: "Nobody knows for sure!"

**Figure 6.4. Costs of Classroom Teaching Versus Multimedia and Computer Conferencing.**




At UBC we now have substantial cost and benefit data on the costs of developing and delivering face-to-face, print-based, videoconferencing, Web-based, and CD-ROM-based courses. We are fairly confident that a standard Web-based course, with a mix of preprepared Web materials, on-line discussion forums, and print in the form of required texts, becomes increasingly more cost-effective than face-to-face teaching as numbers per class increase beyond forty per year over a four-year period. This assumes that interaction between students and teachers remains high. Conversely, we tend to avoid developing distributed learning courses for fewer than twenty students per year. Between twenty and forty students per year per course, any cost differences are likely to be less significant than differences in benefits. For a CD-ROM-based course using lots of multimedia or expert systems, student numbers would need to be in the hundreds annually to become more cost-effective than classroom teaching.

Nevertheless, there is a great lack of hard data on actual costs, not only of the new media but even of conventional teaching in higher education. Much also depends on the design of technology-based teaching, the balance between preprepared material and online discussion forums, and the nature of the face-to-face teaching, such as the balance between large lecture classes and small seminar groups.

One commonly asked question is the ideal ratio of students to a tutor on an on-line course. The answer, of course, is that it all depends! The driving factor is the amount and nature of the interaction between the tutor and students. A course requiring didactic information transmission will have little need for teacher-student interaction, especially if the predesigned learning materials provide feedback, self-assessment tests, and so forth. We have one or two on-line courses of such a nature with one tutor to over a hundred students. Such a course will have high development or fixed costs and low marginal or variable costs, since the tutoring load is minimal.

Another course may require a high degree of student-student and student-teacher interaction because course content is open to different interpretations or needs to be related to highly variable individual student needs. Such a course might be based on readings and discussions. We have several graduate and professional courses of this kind, with fewer than ten students to a tutor. Such a course would have low development or fixed costs and high marginal or variable costs. For a course with a balanced mix of didactic teaching and on-line course discussion, we aim for a ratio of one on4ine tutor to roughly twenty students.

It can be seen that the student-teacher ratio is as much determined by educational philosophy, course design, and student numbers as by technology. The point of this discussion is not so much to compare the costs of face-to-face and technology-based teaching as to show why an understanding of fixed and variable costs and the differences in cost structure between face-to-face and technology-based teaching, is so important.

## Allocating costs

To emphasize this point, I will show how we calculate the costs of our Web-based courses and how we use this calculation to decide on appropriate student numbers, and for full cost-recovery courses, the appropriate fee to charge.

### *Overheads*

A great difficulty in costing technologies is how to assign indirect costs or *overheads.* Overheads are various kinds of costs carried by an organization that are general and difficult to assign to a particular activity.

Buildings are one example of overheads for face-to-face teaching. There are two types of costs associated with buildings: capital and operating. Capital costs tend to be larger, once-only investments in equipment or facilities. The construction and fitting of a building is the obvious example of a fixed capital cost. *Operating* costs - the annual cost, for instance, of heating, cleaning, and maintaining a building - are recurrent costs, that is, they occur every year.

The standard way to handle capital costs for a building (or major equipment purchases) is to average or amortize the costs over the life of the investment by dividing the cost of the building by the number of years it will be used. This will give an annual amortized capital cost. If a building costs $1 million and is expected to last fifty years before being replaced, then the annual amortized cost would be $20,000 per annum. For a classroom building, given the number of students likely to use it over fifty years, the annual amortized capital cost per student is likely to be very small.

If the annual operating cost is added to the annual amortized capital cost, and the sum is divided by the number of users, an overhead cost per user per year can be calculated. This would enable an annual cost per student for use of a classroom building to be calculated. This overhead

cost needs to be added to the direct costs of face-to-face teaching because classrooms are an essential requirement. Similarly, for the purpose of calculating capital costs

for teaching with technology, the cost of the technology infrastructure would be considered an overhead because it is essential for the production and delivery of this type of teaching.

In addition to the costs of physical plant and infrastructure, there are staffing costs that can be considered as overheads. For instance, in my unit, as director, I am not usually directly involved in the production and delivery of courses. I am a general manager. In other words, I am an overhead cost to a particular course. The usual way of dealing with such overhead costs as my salary, benefits, travel, and so forth, is to average them out over each course, that is, to divide the costs by the number of courses generated. This seems reasonable for although I am not a direct cost for a course, my work is (I like to believe) essential for the development and delivery of distance education courses.

Furthermore, my unit is located in the Division of Continuing Studies, which has an associate vice president, a director of administration, and a number of central services such as marketing, accounts, and so on. The whole division is meant to balance its books. These overhead costs too are averaged out over the differ6nt units, including the Distance Education and Technology unit, roughly on a usage basis. For example, the accounts section of Continuing Studies estimates that our unit constitutes about 5 percent of their work, so we get "allocated" 5 percent of their costs, which we have to find from our budget.

In addition, there are a number of other overhead costs, such as computer provision and technical support (we pay about $40,000 per year, or $2,000 per staff member), telephone services, heating and lighting, and so on. Beyond that, there are a number of university central services that we have to cover, such as the central finance office, the president's office, and a whole host of other services, such as registration, human resources, and so on. Our total overheads this year paid from our budget to the university as a whole was $450,000 out of a total budget of $2.4 million-that is, almost 20 percent of our budget. However, without those central services it would be difficult for us to operate. If capital depreciation for buildings, the opportunity value of the land for other developments, and so on, were also included, our overheads would be even higher.

Three main options for handling overhead costs are:

- Not to charge users of the service for overheads (that is, ignore it for costing purposes)
- To average the overhead costs out over each operational function using the service (a cost per program or course using that service)
- To spread the costs over all operational units, whether they use the service or not

Which strategy to use in allowing for overhead costs depends on the type of decision to be made. For a university or college wanting to know whether to invest in a technology, it needs to include all overhead costs, probably adjusted to different bands of activity. It would be reasonable then to allocate these costs to all operational units that might use the technology for teaching purposes, whether they use it or not. When an institution invests in a technology, it should make an estimate of reasonable use, and charge an average cost to reflect that.

To compare the costs of classroom teaching with teaching with technology, it is important to include overhead costs. Over ea costs will differ between the two, and overhead or indirect costs may be more important than direct costs for assessing the costs and benefits of using information technology for teaching. Thus it is strongly recommended that overhead costs be assigned to courses or programs when doing cost analyses, and that these be averaged out over the potential users of the activity. If the overheads associated with the technology are high and

the number of users low, this is an expensive technology, whether or not users are charged for the service.

Given the complexity of estimating and assigning overheads to teaching activities, it is not surprising that many institutions do not bother to assign overheads when costing courses. The overhead costs have to be paid and are often taken off the top. However, one advantage of allocating overheads to direct teaching activities is that it puts pressure on central units to keep down their costs. Once the operating units or faculties see what they must pay for central services such as accounting or technology networks, they often question the level of service being provided by central units. (This is called "whining" by central units, "gouging" by operating units, and "creative tension" by senior management.)

There is growing evidence from our cost studies that overheads and central costs are a large proportion of the total teach*ing* costs (over 50 percent for face-to-face teaching at UBC) and that there are differences in central services needed for face-to-face and technology-based teaching. Therefore, overheads should be calculated and assigned appropriately to courses when making comparisons.

***Shared Costs***

One difficulty in costing technologies for teaching is that the same service is often shared between quite different functional units. For instance, as already mentioned, computer services and networks are often shared between administrative and teaching units. If a network is already in place for administrative purposes, should not the initial investment and operational costs of the network be excluded from the teaching costs?

One way of handling this is to look at the marginal or additional costs of extending the network to teaching. However, technology investment is difficult to unbundle, in terms of function. For instance, at UBC students can register and pay their fees online as well as access their teaching over exactly the same network. It is extremely difficult to separate out the marginal costs of increasing campus network capacity by function and probably not worth the effort, unless one is interested in decisions such as whether to build more classrooms or handle expansion by more off-campus teaching. At that point, some kind of functional analysis of network costs does become worthwhile.

## Identifying Basic Assumptions in Costing Exercises

I have gone through this somewhat complex analysis to indicate how important-and questionable-are the assumptions being made when costing teaching activities. It can be seen why different costing studies can come to completely different conclusions if the assumptions are different between the studies. However, this does not mean that the exercise is meaningless. What matters is that the assumptions be made clear so that alternative analyses can be made on different assumptions.

So, in summary:

- How fixed, capital, overheads, and shared costs are treated should depend on the decisions to be made and who is making the decisions.
- It is recommended that fixed capital technology costs for teaching services be calculated and assigned to all programs or courses that might be expected to use them, and that other overhead costs, as far as possible, also be calculated and assigned to courses and programs on the

basis of whether the service is relevant to the needs of students and teachers using that technology.

- Where teaching shares networks and equipment installed for other purposes, shared costs should be treated as zero unless the marginal costs of using shared facilities for teaching are significant.

## Costing a World Wide Web Program

As part of a national cost-benefit study of telelearning (NCE-Telelearning), we have tracked the costs of developing a number of our Web-based courses. We were able to do this cost analysis partly because these courses had to recover fully their costs and partly because we had a researcher, Silvia Bartolic, who was able to collect data about the time spent by each of the people involved in developing and administering these courses.

The following example is from a postgraduate, one semester, thirteen-week distributed learning course offered over the Internet, requiring an estimated 130 to 150 hours of study. A Web site, which contained a range of resources including on4ine discussion forums, formed the core of the course. Students, however, also required two textbooks and a set of selected readings collected together in the form of a print package, which were mailed to students, who purchased the print materials.

The course in this example is one of five offered internationally as part of a postgraduate certificate program aimed at working professionals. On-campus students at UBC could also take the courses, in distributed learning mode, as an elective within UBC's Master's of Education. The course was also "franchised" to Monterrey Institute of Technology (Monterrey Tech) in Mexico. Monterrey Tech enrolled its own students and provided tutoring and assessment of students, who took these courses as part of its Master's in Educational Technology. Although students enrolled through Monterrey Tech had their own discussion forums moderated by Monterrey Tech's own tutors, the content was the same as for the UBC registered students.

### Hardware, Software, and Operational Costs

Web sites are created using special server software that employs the Hyper Text Transfer Protocol (HTTP). The most popular server software runs on UNIX or Windows NT computers.

Operation and maintenance of Web servers requires someone skilled in computer programming. Furthermore, anyone running a number of courses on a regular basis will need a reliable backup system, so that if a machine fails or requires servicing, there is a parallel service that can take over, enabling twenty-four-hour student access to be maintained.

There are several general approaches to developing Web courses. One common approach is to use HTML to construct Web pages "by hand." Another is to use an integrated Web application (such as WebCT), which can assist the author in all levels of a site's content management and creation.

An organization offering on-line courses will want a system that is as simple and as reliable as possible for those using it in order to avoid high student technical training and support costs.

Student technical support costs can be reduced if students themselves are responsible for obtaining access to the Internet, either through a university's own service or through a local Internet service provider. For the professional courses we are costing, we assumed that students

already had a computer and Internet access. We do not teach students how to use the computer, either.

This approach may not be suitable for other contexts, such as schools, courses aiming to teach students how to use a computer, or inexperienced computer users. In such cases, student technical support costs are likely to be much higher. We also benefitted from the technical support services provided by UBC's campus computer and communications division, as well as from services provided by the library at UBC, which runs courses for students on how to use the Internet for study purposes. These costs are not included.

We have chosen in our Distance Education and Technology unit (DET) to install and run our own suite of servers, and that has required employing highly skilled Internet specialists who are much more expensive than a graduate student helper. On the other hand, our student technical support costs are low (we get very few technical problems with our courses in terms of system operation). Also, the initial high cost of servers and the Internet specialists can be averaged across the growing number of on-line courses we are offering, and even more important, can be set off against the very large savings from not having to provide extensive student technical help services.

## Student Costs

Probably the most important feature of the Web is that it provides "standard" software for end users. In other words, if students have Netscape or Explorer browsers, they have the potential to access anything on the Web. Furthermore, for educational use these browsers are free. For these courses, we originally used off-the-shelf software called HyperNews for our discussion groups. This is free for educational users, although it requires skill in UNIX programming. Provided we design our own Web sites and use free software available over the Web, we have no site license or software costs to carry and neither do our students. We have since switched to using WebCT for these courses, but the costing for this example has been done on the original system.

Systems such as WebCT that do require a site license are also relatively cheap for educational institutions (go to http://homebrew.cs.ubc.ca/webct/get/pricing.html to see the pricing structure). In contrast, the Lotus Notes educational software for developing courses, Learning Space, is much more expensive for end users and more complex to learn. This is one reason we do not use it, although in contexts such as business networks or business courses where users already have Lotus Notes installed for other purposes, it may be a viable option.

For these five postgraduate courses we expected students already to have their own computers. Students accessed the courses from home or work through the Internet. Many of the students in these courses were working or studying at other universities and thus had no difficulty in using their office computer or using computers in local computer labs.

## Costs Over the First Year of a Course

There are several ways to calculate costs:

- Wild guesses ("It costs about the same/more/less for a distance course as a face-to-face course"; "Web courses are about two-thirds the cost of a print-based course"; "Oh, I guess we spend about $10,000 a course")
- Marginal costs, which may reflect just the cash or extra costs needed to put on a course but exclude fixed costs and staff salaries

- Careful estimates of full cost based on experience, including overheads
- Actual costs, as measured by the actual time and money spent on the course, and including overheads

The numbers shown in Table 6.1 are careful full-cost estimates.

Let us look at these costs line by line. It should be noted that all dollars shown are Canadian unless otherwise stated.

***Subject Experts***

Subject experts at $400 a day ($280 in U.S. dollars) is based on two hundred working days a year (removing weekends, holidays, and so on) and including all benefits for an average salary of $80,000 ($56,000 U.S.). This is a graduate course taught by staff in the higher range of academic salaries.

Some would argue that this cost should be excluded because salaries are a fixed cost. However, these courses were new and did not replace an existing program, and because different technologies demand different amounts of time from subject experts it is important to include this cost.

The academic time is also a little high because the estimate included new curriculum development; adapting an existing curriculum would have been less costly in academic time. However, the subject experts in this case were experienced in using the technology; new users will take much longer to develop their first course using a new technology.

## Table 6. 1. Costs of EDST 565f in the First Year.

| *Fixed Costs* | *Dollars* |
|---|---|
| Subject experts (30 days @ C$400 per day) | 12,000 |
| Internet specialist (7 days @ C$300 per day) | 2,100 |
| Graphics and interface design (4 days @ C$300 per day) | 1,200 |
| Copyright clearance | 700 |
| Direct DET costs | 16,000 |
| DET overheads @ 25% of $16,000 | 4,000 |
| Library | 1,000 |
| Server costs | 300 |
| international tutors (3 (& C$1,000) | 3,000 |
| Faculty of education academic approval | 4,000 |
| Total fixed costs | 28,300 |
| *Variable Costs* | |
| Tutoring (40 students @ $220 per student) | 8,800 |
| Delivery costs | |
| Noncredit registration ($14.00 x 29) | 406 |
| Student administration ($28.86 x 40) | 1,155 |
| Printed materials including postage ($37.50 x 40) | 1,500 |
| Total variable costs | 11,861 |
| Total costs to UBC (fixed and variable) | 40,161 |

| *Costs to Students* | UBC Graduate Certificate/ Students | Noncredit |
|---|---|---|
| Fees | 463 | 695 |
| Required readings | 177 | 177 |
| Postage | 0 | 15-100 |
| Internet access | 15 | 21-50 |
| Computer | 0 | 0 |

*Note:* Table shows UBC costs only. Dollars shown are Canadian; C$1.00 = U.S. $0.67.

***Internet Specialist, Graphics and Interface Design***

In order to ensure easy navigation of the course, a "clean" look, and minimum download speeds, input from an Internet specialist and a graphics and interface design specialist is strongly recommended for all on-line courses, whether using off-the-shelf software such as WebCT or not. This course was what we call a "roll-your own" HTML course. In other words, we designed the interface because with different groups of students registered with ITESM in Mexico and with UBC, we could not at the time use a standard interface. Also, when the first course was designed, most off-the-shelf packages were still in a developmental stage. Designing our own interface also had the advantage of not having to pay software license fees.

On this course, three *international guest* tutors (including the authors of the required textbooks) were invited to moderate a discussion for a week each. However, this did not replace regular tutoring activity and so was an additional cost.

Normally for courses developed by our unit, there would be an additional line item for *project management-instructional design.* However, unusually, the subject experts also happened to be project managers-instructional designers by background, so this is rolled into subject expert costs. Normally, this would be a separate line item (we would allow a maximum of ten days or $4,000 for a one semester course for this function).

***Copyright Clearance***

Copyright clearance was required for the collection of printed custom course materials (selected journal articles or chapters from books) that accompanied the course.

***DET Costs***

DET overheads covered the overheads referred to earlier, including a charge from UBC's central computers and communications division for network access, and for the costs of staff workstations.

***Library***

The UBC library provided two services to the course. A librarian was a member of the course team and helped identify relevant readings (both printed and on4ine) for the course, and UBC students could go on4ine to the library catalogues and order any journal articles or books, which, for a small fee, were faxed or mailed to students.

***Server***

Server costs are amortized over three years, the average life of a computer these days. We have two servers-one a backup-at a total cost of $9,000. We are developing approximately ten new Web courses a year, or thirty over three years, so the average cost per course is $9,000 -- 30 = $300. Even this cost is probably too high, because the servers are used for other purposes besides course development and delivery.

### *Academic Approval*

There was for this course a charge of $4,000 from the Faculty of Education for their costs in giving academic approval to this course. This is an unusual cost (some would say cruel and unusual), because if the course had been developed in the Faculty of Education (or any other faculty), this cost would have been zero. However, it does compensate for the time spent by academics in the faculty on reviewing and approving the educational quality of the courses.

### *Tutoring*

Tutor costs are based on an estimate of actual time spent tutoring this course, including moderating on4ine discussions, dealing with e-mail from students and the course team, and marking assignments, averaged across each student. On this particular course, there were three tutors team-tutoring (the instructors who designed and developed the course) with a tutor-student ratio of 1:13. This may seem high for a graduate course, but ten of the forty students were auditing, taking the course but not submitting assignments or being graded.

### *Delivery*

Delivery costs are based on the average costs, developed over a large number of courses, for registering and administering distance education students. Note that registration costs exclude the UBC graduate students, who were already registered before this course began. Their registration costs are covered in the overheads charged by the university to our unit on credit student tuition fees.

The *variable* cost to UBC for each student is $300 ($220 for tutoring plus $80 for materials and administration). This is also the marginal cost to UBC of adding another student to the course. If we added in the $177 that the student pays for printed materials, the total variable cost per student would be $477, plus any computer and communications costs that the student bears.

### *Revenues*

We should also look at *revenues.* For every graduate student on a three-credit master's course, our unit receives $463 from UBC graduate tuition revenues. For the certificate and noncredit students, these courses have to be self-financing, because the provincial government does not subsidize noncredit programming. We therefore set a charge of $695 for the certificate and noncredit students (see the next section on pricing policies). We also received payment from Monterrey Tech for half the cost of development, but this has not been included in these calculations.

### *Students' Costs*

In addition to the fees, students pay the full cost of printed materials. For EDST 565f, there were two set books, costing a total of $120, plus the custom course materials at $56.65 a set, plus postage (an average of $15 for Canadian students and $30 for international students, although the costs varied a great deal, as some students paid courier fees).

Finally, students have to find the cost of a computer and Internet access. These are very difficult to allocate, particularly if a student has a computer for other purposes, where the marginal cost for this course might be considered zero. The cost of Internet access varies also, from as low as $15 a month to over $50 a month, depending on location.

I have gone through these costs in detail so that it can be seen how they were derived. This illustrates the point that costing is like playing golf If you cheat, it is between you and God-no one else is likely to know! It does demand self-discipline and honesty to ensure that all costs are included.

However, we are not ready yet to calculate average costs, because we have to look at the costs over the life of the course, and not just in the first year in which it is offered.

## Costs Over the Life of a Course

We do not know yet what the life of EDST 565f will be, but I expect it will have four presentations (one a year over four years). I have also assumed that the course will continue to enroll forty students per year.

With print-based courses, we spend about 10 percent of the original development cost per year in maintaining and updating courses. However, with Web-based courses this maintenance cost is usually higher because the subject experts are continually adding and replacing Web sites, references, readings, and so forth. I have assumed then a maintenance cost of 33 percent, or ten days per year of subject expert time.

The Internet specialist spent two days setting up the site and the equivalent of five days maintaining it in the first year. He is also likely to have to spend the equivalent of five days per year maintenance on this course during each presentation. The graphics and interface designer will need to spend one day making minor corrections or changes to the course in the second year, taking into account student and tutor feedback, but it should remain stable after that. Copyright, though, will have to be paid each year for reproducing the readings.

There was a one-off cost for the services of the librarian in the first year for helping to locate appropriate readings. Similarly, the fixed costs of the server were written off in the first year. In contrast, the international tutors need to be paid each year. Faculty approval is also a one-time cost per course. Tutoring and delivery costs will be constant over the four years, provided student enrollments stay the same each year.

Using these assumptions, I have broken down the likely costs as follows (see Table 6.2):
The total cost then of this course over four years is $108,209 ($75,746 U.S.) for a total of 160 students (4 x 40).

Once we have the full costs of a course at this level of detail, we can start doing some useful calculations, depending on our purpose. Indeed, we can now start changing some assumptions, thus modeling" costs.

**Table 6.2. Costs of EDST 565f Over Four Years.**

| | *Year 1* | *Year 2* | *Year 3* | *Year 4* | *Total Dollars* |
|---|---|---|---|---|---|
| *Fixed Costs* | | | | | |
| Subject experts | 12,000 | 4,000 | 4,000 | 4,000 | 24,000 |
| Internet specialist | 2,100 | 1,500 | 1,500 | 1,500 | 6,600 |
| Design | 1,200 | 300 | 0 | 0 | 1,500 |
| Copyright | 700 | 700 | 700 | 700 | 2,800 |
| Subtotal | 16,000 | 6,500 | 6,200 | 6,200 | 34,900 |
| | | | | | |
| DET overheads | 4,000 | 1,625 | 1,550 | 1,550 | 8,725 |
| Library | 1,000 | 0 | 0 | 0 | 1,000 |
| Server | 300 | 0 | 0 | 0 | 300 |
| International tutors | 3,000 | 3,000 | 3,000 | 3,000 | 12,000 |
| Faculty approval | 4,000 | 0 | 0 | 0 | 4,000 |
| Total fixed | 28,300 | 11,125 | 10,750 | 10,750 | 60,925 |
| | | | | | |
| *Variable- Costs* | | | | | |
| Tutoring | 8,800 | 8,800 | 8,800 | 8,800 | 35,200 |
| Delivery | 3,021 | 3,021 | 3,021 | 3,021 | 12,084 |
| Total variable | 11,821 | 11,821 | 11,821 | 11,821 | 47,284 |
| Total all costs | 40,121 | 22,946 | 22,571 | 22,571 | 108,209 |

*Note:* Table shows UBC costs only. Dollars shown are Canadian;
C$1.00 = U.S. $0.67.

## Calculating Total Costs

I will continue to use EDST 565f as an example.

### *Average Cost per Student*

The easiest cost to calculate is the average cost per student. The average cost per UBC student in the first year appeared to be $1,003 ($40,121/40). However, the true average cost over four years is $676 ($108,209 160), or $473 U.S. (If you were wondering how we set the student fee for certificate students at $695, now you know!) These are the costs, of course, to UBC. If one added in the printed materials that the student pays for, the total average cost is approximately $850, plus any computer and communications costs. . Each time the course is offered, the average cost per student comes down, so the life of the course, or the number of times it is offered, is significant. This is one indication of how the costs of technology-based teaching differ from face-to-face teaching.

### *Total Costs*

The total costs over the four years at forty students a year was $108,209.

***Pricing and Paying for Courses***

Perhaps the most important decision that needs to be made when choosing technologies is how to calculate the price of a course so that costs are covered (or exceeded) by revenues or income.

In education and training there are several potential sources of funding: grants or subsidies from government or an employer, student fees, secondary sales of materials, franchising or copyright (fees paid by another organization in order to use the materials or offer the course), and advertising or sponsorship. For this exercise, I will assume that a course must at least cover all its costs from student fees. Three variables will affect whether this can be achieved: the cost of the course, the number of (paying) students, and the level (or price) of the fee.

We can vary each of these three variables and still achieve full cost recovery. For instance, if we know the likely number of students and the maximum they are likely to pay, we can calculate how much (or little) the production and delivery of the course must cost, as follows:

COST OF COURSE
STUDENT NUMBERS x COST OF FEES

If we know how much the course will cost, and the maximum fee we can charge, we can work out how many students will be needed to break even, as follows:

NUMBERS OF STUDENTS
COST OF COURSE / COST OF FEE

And if we know the cost of the course and the likely number of students, we can work out the optimum student fee to cover costs, as follows:

STUDENT FEE
TOTAL COSTS/NUMBER OF STUDENTS

Last, we can vary all three, or model different scenarios. Usually when designing a course, you have to play around with all three variables, which is where the cost of using particular technologies becomes critical.

By building a model of costs around these three variables, it is possible to develop the financial elements of a business plan that can help decide whether to go ahead with the development of a particular course.

Taking EDST 565f as an example, we worked out how many full fee-paying students were needed to make this course viable, because access issues and teaching requirements largely determined the technologies. Also, our on-campus, face-to-face certificate programs were charging about $700 per course. This is how we did it:

IF STUDENT NUMBERS = TOTAL COSTS /COST OF FEE,
THEN STUDENT NUMBERS = $108,209 /695.
THIS COMES TO 156 STUDENTS OVER FOUR YEARS,
OR 39 STUDENTS PER YEAR.

We did in fact get forty fee-paying students in the first year (although not all were full fee paying, as eleven were master's students, but they are also subsidized through government grant).

This is a very useful technique when assessing what technologies to use, or even more important, whether to go ahead with course production or not.

## Developing In-House On-Line Courses Versus Outsourcing

A good arrangement for an individual or an organization wanting to run only one or two courses is to contract out the work as long as the external contractor can provide a high-quality and completely reliable service. Indeed, it is possible to hire commercial organizations such as e-College.com to develop and host a whole course.

Outsourcing is not such a good arrangement for an organization that is developing a large number of its own courses. Different courses require different designs, and one single authoring system may not be able to cope with this variety. Furthermore, an organization running a large number of on-line courses will want to ensure that the service is completely reliable, and will want easy access to the host server so that changes can be made and the priority of the organization in getting those changes made is met.

For small or medium-size universities, the decision about whether to outsource can be difficult. A number of factors have to be taken into account besides costs. If technology-based teaching is seen as core and central to the activities of the institution, it is probably advisable for it to develop its own in-house capacity. An organization with an already existing and competent in-house capacity and a large number of courses to develop would be better to support the internal unit than to contract in from outside. In contrast, an institution may have in-house capacity but it may not be cost-efficient, or it may be unresponsive to internal clients, or it may not be able or willing to adapt to changes in new technologies. These may all be reasons for bypassing the internal unit and outsourcing. However, if an agency external to the institution is to be contracted, then costs need to be examined carefully. What may look like a good deal may on closer examination prove to be an expensive option.

First, there is the issue of quality. What is included in the contract? For instance, will the external contractor provide instructional design, and a range of options and advice on software, teaching methods, and delivery? Will the materials be tailored to the needs of off-campus or distance students? Will the contracted service include interface design, and navigation tools, so that students can easily find their way round the course?

Second, who is going to do the bulk of the work? Who has to pull together all the material to be put on the Web site, get it into a suitable format, and clear copyright? If this is not to be done by the service provider, then major costs will fall on the academic staff or teaching department.

Third, does the contract permit changes to be made at a reasonable cost? For instance, if alterations or additional materials are necessary during the first offering of the course, is there an extra charge for this? If so, what will it be? (Some contracts require the same fee for any alterations as for the original work.) Who is responsible for checking the accuracy and reliability of the work, and for making changes and course maintenance, and how quickly can changes be made?

Fourth, who is responsible for tutoring? How will this be paid for? For instance, some contractors charge a low initial cost to put information up on the Web but then charge $100 (U.S. dollars) for every student. The economic benefit of this to the outsourcing institution will depend to some extent on the level of tuition fees that can be charged, and how they can be used. For

instance, government sets tuition fees for undergraduate courses in British Columbia at roughly $250 ($175 U.S.) per three-credit course. The Distance Education and Technology unit at UBC gets these fees and uses them to pay for the cost of reproducing and delivering materials to students (print, mailing). We also use funds from fees to pay tutors, who mark assignments and assess students. The fee more or less balances the direct marginal cost per student. A department using an outside contractor to develop a course would have a major problem, even if allowed to keep the $250 tuition fee. It would not be able to cover even the cost of tuition ($180 per student or $120 U.S.), after paying $ 150 per student ($ 100 U.S.) to the external contractor.

Finally, what counts as a direct cost for in-house production and where does it come from? Contracting out may save costs on internal course developers but is likely to increase the work for academics, depending on the external contract and the service provided. Furthermore, the university provides money off the top for distance education course development at UBC, which includes paying for the time of the academic to work on on-line courses. Why would a department pay out hard cash to an external contractor and still have to do a major part of the work when it can receive additional internal funds for developing the course in house? However, the provost may want to compare the costs of external contractors with in-house services. At that level, outsourcing may look to be a better deal, particularly if there is no in-house service or if the in-house service seems inefficient or expensive to run.

In the end, it is likely to come down to quality rather than cost. External contractors tend to "cream" the easy work. Putting materials already created for classrooms up on to the Web is the easy part. Adapting or creating original materials that exploit online use, developing an institutional look and feel, putting in and running effective discussion forums, and providing quality tutoring and assignment marking are all labor-intensive and expensive. If external contractors can do all these things more cheaply and better than an in-house team, then it would make sense to outsource. Whatever the circumstances, a careful cost-benefit analysis at an institutional and departmental level should be done before outsourcing.

## Technology as Classroom Aid

It is much easier to identify the costs of delivering teaching entirely at a distance through new technologies because it can be isolated as a relatively separate activity. It is much more difficult to calculate the costs of using technology to support regular classroom teaching, because it becomes so integrated with other regular costs.

Traditional teaching in higher education comes with a very high proportion of indirect costs. The Budget and Planning Office at UBC has done a detailed breakdown of the direct and indirect costs of teaching there. Indirect costs (buildings, central services such as the registry, the president's office, sewage, taxes, the library, general administration, information technology services, and so forth) when loaded back on a per-student basis constitute 53 percent of general-purpose operating funds. Thus, after stripping out research costs (and allocating their share of indirect costs), salaries of faculties and faculty support staff constitute only 47 percent of the operating funds spent on teaching.

The costs of technology supporting classroom teaching, such as the development of Web sites, are buried within the salaries and time of instructors and research students, as well as clearly identified educational technology support staff (direct costs), and within the technology infrastructure costs (indirect costs). To assess the real cost of the use of technology for

supporting classroom teaching, these costs need to be identified. However, few higher education institutions have financial systems in place that enable this analysis to be done easily.

Nevertheless, some conclusions can be drawn.

- If the use of technology to support classroom technology does not result in savings in other activities, then costs will inevitably increase.
- It has proved difficult to show a direct relationship between increased learning performance and increased use of technology to supplement classroom teaching (this issue will be discussed in more detail in Chapter Nine).
- By far the largest cost in using technology to supplement classroom teaching is the time spent by instructors and their research students in developing PowerPoint presentations, Web sites, CD-ROMS, and so on.
- We have seen in Chapter Five that to make better use of faculty members' time and skills, more technical support is required than has been provided in most institutions to date. This will lead to further increases in cost, although increased research output and greater learning gains may compensate for this. However, there is little research evidence to date to support (or refute) this assumption.
- Finally, the impact of using new technologies to support classroom teaching is an area where research is urgently needed, an issue that is also discussed in more detail in Chapter Nine.

## Putting in Appropriate Financial Systems

Most university and college financial systems are what might be termed *expenditure-driven*. Allocations of resources (mainly teaching and support staff) are made to faculties, and hence to departments, and the financial system tracks whether expenditures are consistent with allocations for salaries, benefits, expenses, materials, and so on. These budget lines are not related to specific activities, such as the cost of teaching a particular course. It is thus impossible to use financial reports based on an expenditure driven model to analyze the costs of different courses, or different delivery mechanisms.

In addition, most publicly funded institutions until recently have received their funds in the form of a block "general purpose operating grant" from government, which is then broken down into smaller blocks for each faculty and then for each department. In many institutions, student fees are collected centrally and then reallocated as part of the block grant, independently of the courses or departments that generated the revenues. Consequently, there is often a single "target" figure for expenditure, and university and college accounts are not physically structured to account for and track revenues from multiple sources.

Because at UBC we still have an expenditure-based financial system, I have to keep two separate but related sets of accounts. One is the "university-divisional" set, and the other is the set I use for tracking the expenditures and revenues for each of the over one hundred projects or courses we have at any one time. The data for our project-based accounts all have to be entered separately, by my staff, but at the end of the day the totals of expenditures and revenues across the projects have to balance with the figures in the university's expenditure-driven accounts. This is a hugely inefficient system.

This is not specifically a problem caused by technology-based teaching; it applies particularly to cost-recovery units such as continuing studies or extension divisions that depend

on tracking revenues as well as expenditures and need to know which activities or projects are breaking even, losing money, or making a profit.

It is also a problem with a solution. There are now administrative software systems available based on relational databases that allow the same data to be entered and analyzed locally for both expenditure-driven and activity-based accounting. However, there is a very high initial cost in researching and installing such systems.

Nevertheless, such systems will become increasingly necessary if institutions are to understand and control the costs of technology-based teaching. Despite the hazards involved in costing technology-based teaching (or teaching of any kind, for that matter), it will become increasingly important to put in place financial systems that allow expenditures and revenues to be tracked and allocated accurately on an activity basis. Only in this way will managers be able to make accurate assessments of the costs of different kinds of teaching. Without such activity-based financial systems, for instance, the decision to outsource or not will be purely subjective.

## Conclusions

It is worth remembering the story about the company that was appointing a new chief accountant. Each candidate was asked a set of questions by the interviewing committee. The owner of the company asked only one question of each candidate, right at the end of the interview: "What's two plus two?" Each of the candidates looked puzzled and answered, "Four." When the last candidate came in, the owner again waited until the end and asked his question: "What's two plus two?" "What would you like it to be?" replied the candidate. He got the job.

One would like to think that there are more ethics in education and training than in business accountancy. However, as with all jokes, there is a point to the story. How one costs teaching by technology will depend on the kind of decisions to be made and what your position is in the decision-making chain. What is important is that all costs be identified, that the assumptions underlying the costings be transparent and understood, and that reasons for including or excluding the various cost lines or headings be valid for the purpose of the exercise.

What cost data we have suggests that the direct costs of well-managed technology-based teaching compare increasingly favorably with the direct costs of well-managed face-to-face teaching, particularly as student numbers for a particular course or program increases.

What we do not yet know is the impact of technology-based teaching on indirect costs or indirect benefits. There is some evidence that technology-based teaching could have significant potential advantages over face-to-face teaching when it comes to indirect costs and benefits. For instance, distributed learning could lead to reduced demand for new buildings, reductions in traffic to and from campus, and widening access to new target groups of learners. What we need are better methodologies and better financial systems for tracking revenues and expenditures, and more studies on the costs and benefits of both face-to-face and technology-based teaching.