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## **The costs of open learning: a handbook**

**(with an introduction by Hilary Perraton)**

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Hilary Perraton and Thomas Hülsmann

# The costs of open learning: a handbook

## Introduction

This book is designed to help educational managers who are deciding how to use open and distance learning. It examines the comparative costs of various educational technologies, suggests how we can examine and control costs, and sets out some of the difficulties in doing this. The second half of the book consists of eleven case studies.

The work has been carried out with funding from the European Commission's Socrates programme. We are indebted to them for their support and to the staff of the institutions where we carried out case studies for their interest, cooperation and help.

Open and distance learning has grown dramatically over the last twenty-five years. In many industrialised countries, between six and twelve per cent of all enrolments in higher education are of students studying at a distance. The world now has more than thirty open universities. Perhaps as important, the lines between conventional education and open and distance learning are becoming blurred. Australian universities have started to talk about 'flexible learning'. Within Britain at least half of all universities now have some open-learning programmes. Increasingly, institutions are teaching both through ordinary classrooms and lectures and through open learning. Increasingly, too, students are taking some courses through one mode and some through another. On our doorstep, for example, Anglia Polytechnic University used to teach all its students within its campuses. Today it teaches some on campus, some by franchising courses to other institutions, and some through open learning techniques.

These changes present a double challenge for educational managers. First, managers need to choose the technologies that are most appropriate for the course they are teaching and the students who are following it. Second, they need to look at the cost implications of using open and distance learning.

These intertwined challenges are more complex than at first sight appear. The costs of conventional education are mainly determined by the cost of buildings - from halls of residence to laboratories and classrooms - and the costs of staff. As student numbers increase, so staffing costs increase, although the rise may be tempered by changes in staffing ratios. In open and distance learning, the picture is more complicated with some expenditure on the production of materials, which may be used for any number of students, and some on student support. The cost of preparing materials in different formats will vary: generally, for example, producing materials in print is relatively cheap and in television relatively dear but there may be social and educational reasons for avoiding the cheapest option. The use of computers in education has added a new layer of complexity to the analysis of costs. They make it possible for example, to distribute material cheaply and to allow students increased interaction with each other and with their tutors, but at the price of demanding investment by the student in a computer and a modem and sometimes of transferring the cost from the teaching institution to the individual student.

Within the project whose results are reported in this book, we have tried to look at some of these complexities. We have done so both by reviewing what is already known about the cost of open and distance learning and by carrying out eleven case studies with colleagues within institutions in Britain, France, Germany, Italy, Norway and Spain. We have used a common framework for examining and analysing costs, looked at the choices of technology that have actually been made by people running educational programmes, and reached some general conclusions to guide decision makers. Table 1.1 sets out the case studies we carried out with summary information on the technologies used.

Our findings are set out in five general chapters in the first half of the book and in the summary case studies which appear as the second part.

Our major findings, on the comparative costs of different technologies and on the factors that affect these, are dealt with in chapter one. In order to put these findings in context, we then move on, in chapter two, to explain the methodology we used and then in chapter three, to discuss the difficulty of interpreting the findings. This makes it possible for us, in chapter four, to produce guidance for the manager on applying the findings and the methodology that have been used and in chapter five to examine some of the issues involved in justifying decisions that follow.

The findings are based on quite different case studies. While they vary widely, all of them fit within a set of definitions agreed for IRFOL's work generally:

We have used the term 'open and distance learning' as an umbrella term for our sphere of interest. It covers distance education, open learning and the use of telematics in education. We have working definitions of each of these, although the way the terms are used varies with location: something called distance education in one place is called open learning in another. The definitions are:

Distance education is an educational process in which a significant proportion of the teaching is conducted by someone removed in space and/or time from the learner.

Open learning is an organised educational activity, based on the use of teaching materials, in which constraints on study are minimised in terms either of access, or of time and place, pace, method of study, or any combination of these.

Telematics is the combined use of telecommunication and computer technology.

Hilary Perraton

## Part I

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## 1 What we found

Open and distance learning can use a variety of media and, as information technology develops, so the range of choice gets wider. Many open and distance learning programmes combine some face-to-face teaching with technology-based teaching. Managers are, therefore, faced with choices between technologies, and between mediated communication in one form or another and face-to-face teaching. The aim of this study was to inform the choices they have to make.

At the simplest, if we have decided to use open and distance learning, we can make comparisons between four sets of technologies. First comes print: for many purposes it provides the cheapest and most convenient way of recording teaching and making it available to students who are working at a distance, or away from a teacher. Next, material can be provided in sound, either on audiocassettes or, if an institution has access to broadcasting, by radio. Third, we have a set of different ways of using audiovisual communication: through videocassettes, through closed circuit television, as with videoconferencing, and through open circuit broadcasting. Fourth, computers can be used for a variety of different teaching purposes. This classification may be over simple, and even its boundaries may be blurred. Computer technology, for example, can be used to offer audio or video images, or to carry print. But it is a useful place to begin.

### Comparing costs

The purpose of our research has been to develop tools that will be useful for educational managers. In doing so, we have concentrated heavily on examining the costs of different ways of running open and distance learning. Much of our argument, and much of the evidence that follows is about costs. We need therefore to begin with a disclaimer. It is no part of our argument to suggest that educational decisions should be taken on economic ground alone. Nor are we suggesting that we can leave aside questions of effectiveness. It would be rewarding - but would demand far more resources - to look at the comparative effectiveness of different approaches to open learning. We are, however, suggesting that it is easier to make sound educational decisions if we begin with an understanding of what they are likely to cost. The rest of this chapter therefore looks at the comparative costs of various different teaching media.

Our starting point is that the manager will make a choice between alternative technologies on the basis of the social and educational cases for choosing, say, print for part of a course, an audio recording for another part, and some form of computer-based learning for another and, in making that choice will want to know about their comparative costs. Furthermore, in choosing between media or technologies, the manager can be relaxed about the question of effectiveness: the research literature on the effectiveness of educational media shows consistently that the choice of medium does not affect outcomes in terms of learning (Clark, 1983). (We look at the question of media effectiveness more fully in chapter 3.)

As a result, the educational manager can choose between alternative technologies, confident that the choice is not likely to affect learning - though it may have major consequences for learners in terms of convenience, access, or motivation. That confidence makes it all-important to consider the cost of alternatives, and the different ways the costs for different media behave. The cost of each choice provides a vital piece of information to help make management decisions.

Of course, cost is not the only consideration. The choice of media will also be affected by questions of the appropriateness of a particular medium for the educational process and aims of the course. Each medium is likely to have strengths and weaknesses that appeal to a manager, and to the eventual students. Print, no matter how unglamorous, is convenient for students and teachers, easy to use, and demands no more than literacy, a press or its equivalent, and a postal system to become available to students. Audio and video have obvious advantages for presenting aural material, for demonstrating examples or offering simulations, and for altering the pace and texture of study. Broadcast radio and television, despite the inconvenience of their fixed hours, may be valuable for motivating students and for providing a shop window. An increasing number of institutions also want to have a shop window on the Internet. Alongside any pedagogical advantages of using computer-based teaching, of one kind or another, there may be institutional pressures to use computer links alongside other means of communication. Our concentration on cost is not intended to downplay the educational and social reasons for using one medium rather than another. Instead it is intended to provide neutral information that will allow managers to make trade-offs between the cost of the simplest option and the likely benefits of anything more sophisticated.

In order to identify and compare the costs of open and distance learning we need to overcome three difficulties. All are peculiar to open and distance learning and do not apply to the analysis of conventional education. First, as open and distance learning usually depends upon the production of teaching materials, that may be used over a number of years, we cannot simply divide the recurrent costs by the number of students, as we can if we want to calculate a crude, annual cost per student for conventional education. Second, if we want to look at cost effectiveness, we need to consider not just the costs of developing materials and supporting students, but also the total number of students likely to be enrolled over a number of years. Only with this information we can work out a cost per student. Third, within open and distance learning, we have an apple and orange problem. In order to make rational choices of medium, the manager needs to compare media that are, apparently, as different as a printed book and a videocassette.

To overcome these problems we have sought, as far as possible, to use a single, standard measure to compare the costs of different technologies - the student learning hour. Thus, in considering printed materials, for example, we have sought the best information on the number of hours that the average student will spend in working through the text. This makes it possible not just to calculate a cost per page - useful for comparing one text with another - but a cost per student learning hour. Similarly we have sought information on the time it will take to develop, say, an hour of teaching recorded on an audiocassette or the preparation of an hour of computer-based learning. Most of our calculations have therefore used the same common currency, comparing the costs required to provide for a given amount of study time using different media. A book may cost £20 000 to write and to produce and occupy a reader for forty hours. A television programme may last only for an hour but may cost £120 000 to create. The respective costs per learning hour are £120 000 per hour for television and £500 per hour for the book.

We were encouraged to accept the student learning hour as a common measure, despite its apparent arbitrariness, because it is actually in use. Increasingly institutions developing open and distance learning courses indicate the learning time the average student is expected to set aside for studying. Similarly, learning time is increasingly being used in relation to credit recognition and transfer. Within higher education in Britain, for example the credit accumulation and transfer (CAT) point system has been developed to compare degrees and modular courses within them, in part to facilitate student mobility. CAT specifications, with a formally stated rate of exchange with student learning hours, provide a possible planning framework for those working on the development of teaching materials.

Then we have found it useful to distinguish between two different uses of technology - as resource media or as communication media. We have used the term 'resource medium' for any medium which is used to convey instruction, presenting teaching material to students in what is principally a one-way mode of communication. By 'communication media' we mean the use of media for communication between student and tutor or among students. Resource media inform, communication media allow dialogue. Some media - print for example - lend themselves very much to use as a resource. Others - computer conferencing - are more likely to be used for communication.

Both resource and communication media are necessary for education but their costs behave differently. In using resource media we can expect to find some economies of scale. While some print costs, for example, rise with increasing number of students, for paper, reproduction, and distribution, much of the total cost represents academic staff time. This cost is fixed so that the cost per student falls as more students enrol. With most communication media, however, costs are a function of the number of students, or in some cases the number of groups of students. There are, for example, no economies of scale in offering telephone tutoring to students.



By carrying out a series of case studies, and examining them in the light of existing literature on educational cost-effectiveness, we were able to reach some general conclusions about the costs of both resource media and communication media. The case studies are summarised in table 1.1 and discussed more fully in Chapter 2.

**Table 1.1: Case studies (overview)**

Name of institution	Country	Course title/ Subject area	Technology configuration
Open University	United Kingdom	Studies in health and social welfare	Print, audio and video
Open University	United Kingdom	Mathematics	Print, television, video and CD-ROM
NKS	Norway	Adult secondary education	Print and video
NKS	Norway	Teacher education/ upgrading	Print and video
FVL	Germany	Business engineering	Print
ZEF Oldenburg	Germany	Professional development	Print
Anglia Polytechnic University	United Kingdom	Studies in health and social welfare	Print, television, video, Internet, videoconferencing, computer conferencing
Université de Dijon	France	Philosophy	Print and audio
Poltecnico di Milano	Italy	Engineering	Video-conferencing
ZEF Oldenburg/ UMUC	Germany/USA	Distance education	Online
Universita Oberta de Catalunya	Spain	Law	Print

## **The costs of resource media**

Resource media, used to carry teaching to students, provide the backbone for open and distance learning. They form an indispensable framework, for their study, even where ample opportunities for dialogue are provided for communication media. Investment - especially in staff time but sometimes also in a particular technology - is necessary if teaching is to be recorded and made available through resource media. The manager therefore needs to be able to analyse and forecast the costs involved in developing and using resource media, and to see where it may be possible to achieve the economies of scale that they make possible. With our colleagues, we therefore looked at the costs involved in using various resource media: print, audio or videocassettes, open circuit television, and the use of computers in education. In each case we looked both at the fixed costs, which are principally the costs of developing teaching material and are unaffected by student numbers, and the variable costs, which are mainly for distribution, where costs vary with the number of students.

### *Fixed costs*

We start with *print*, the simplest technology. Most teaching starts with the preparation of a text and the simplest and cheapest way of reproducing and distributing that text is still to use print. Even if we are developing computer-based teaching or writing computer software a text is usually the starting point. The preparation of a text forms a significant proportion of the cost of producing printed materials. Thus we have treated print as a default option, treating its costs as a point of comparison for the other media that may be available for open and distance learning.

On average we found that one hour of student learning, provided in the medium of print, costs £350 and that, as a rule of thumb, ten student learning hours demand some 50 pages of print. This means that 50 pages of print cost about £3 500. About half of it goes to the author, with the rest being required for the costs of instructional design and editing as well as the preparation of copy for printing.

Print remains the most important medium for distance teaching. Much material is distributed conventionally but it is now also possible to deliver teaching material to students on the Internet. Although we consider the use of computers in open and distance learning below, it is appropriate to look here at the implications of using the Internet as a distribution medium.

The Internet allows text presentation on the screen instead on the printed page. This saves the cost to the institution for distribution although it may also mean that the user prints out a visually inferior version of the text. The development costs of text on screen might be expected to be the same as for printing. They include writing the text, layout and design. However, course managers express reluctance to distribute text on the Internet, unless it uses some of the design options available in the digitised medium. It is assumed that learner expectations would be frustrated if neither hyperlinks were edited in nor browsing facilities made available. The lesson from this is that the potential of a technology creates expectations, which exert an upward pressure on costs.

In the case study from Anglia Polytechnic University the Internet was used to present a text, which had been re-edited in hypertext format. The cost for the Internet version therefore had to include the authoring cost and at least some of the cost related to text design and layout. The APU experience suggests that the development costs double when a text is re-designed for the Internet.

Generally, therefore, we would expect the use of the Internet rather than conventional print at least to double costs, and quite often to increase them much more than this. A tenfold increase may not be unusual. The use of the Internet also transfers distribution (or, more strictly, reproduction) costs from the institution to the student, and may result in the student's having a lower quality of print once material has been printed from the screen. These disadvantages need to be set against the advantage of rapid distribution and the benefits of adding hyperlinks and other computer-based enhancements.

Both *audio and videocassettes* are of potential value for open and distance learning. We found only occasional use of audiocassettes, although reports on their costs have been made previously. The available costs suggest that the cost of preparing learning material for a similar number of student learning hours is about five times of producing print. (Broadcasting agencies, using higher standards of production, report a larger difference.) The increased cost is explained mainly by the amount of staff time needed to produce effective teaching materials in audio format. Video turns out to be a relatively expensive medium. We have reported one case where the video development costs is significant lower but it turned out to be a re-use of a live satellite transmission, the production cost of which were not included.

*Open circuit television* appears to be the least cost-effective of the media we examined. Indeed the role of television in distance education appears to have changed having become less an integral part of the weekly process of teaching and learning and more a window display to attract potential learners.

We have used the phrase *computer-based teaching* to cover a variety of different uses of computers within education. In looking at their costs, we run into an immediate difficulty as some computer applications cut across the neat distinction between resource and communication media. It may be possible to use a computer network, for example, both to carry resources from the institution to the student and to offer a tutorial service. For our purposes, we have found it convenient to distinguish between three broad categories of computer use: as a distribution medium, for interaction between the student and the computer, and for interaction between students and tutors. We will come back to the third category in looking at communication media.

First, as we saw in relation to print, we can use computers simply as a means of distributing material to students. We may do this by putting material onto a CD-ROM, or by using the Internet. In both cases, there may be pressure to offer something more than straightforward text, as the medium facilitates this. But, at this level, we are simply treating computer technology as an alternative way of distributing resource media, alongside physical methods of distribution.

Second, computers have been used in a variety of ways in which students interact with materials available through the computer and in which that interaction is at the heart of the learning process. (The early application of computers to education was dominated by computer-assisted learning in which students interacted with a computer program instead of a teacher.) Computers are being used in half a dozen different ways here. Computer-marked assignments are used by some institutions alongside tutor-marked assignments. Interactive computer-marked assignments are more complex and are designed to provide fuller information as feedback to students. Students may use computer tools, such as standard wordprocessing and spreadsheet programs. In order to help their study, they may use the computer to access databases. In contrast with these approaches, computer-assisted learning requires the development, or purchase, of programs that are designed to teach. In the case of interactive computer-assisted learning, these programs include items such as film or video simulations as well as text-based material. In all these cases, the student is interacting with a computer program rather than using the computer as a means of getting resources or communicating with an individual.

In our studies we found that materials had most often been made available in CD-ROM format. CD-ROM can be designed as a highly interactive medium with consequent high development costs. The cost per student learning hour varies considerably, according to the sophistication of the use of the medium. We found some development costs of £13 000 per student learning hour and know of cases of investment of nearly £20 000 per student learning hour. Data on cost depended here on rather subjective information from course designers who have rarely kept good data on the amount of time spent in developing teaching material. Our best estimate from the case studies is that it costs forty times as much to produce material in CD-ROM format as in print. Despite this high fixed cost, CD-ROM proved to have lower development costs per student learning hour, in the cases studied, than video or television. Development costs of CD-ROM may come down where it is possible to develop shells (a sort of CD-ROM template), which can be re-used for different purposes.

We were able to examine the cost implications of a number of the possible options available for computer-based teaching. To help comparison, we refer to one hour of student learning. These calculations of learning time are based on the intentions of the course designers rather than on empirical research of the actual time spent by students. We found some costs for preparing computer-marked assignments, for customising software, for work on databases and for computer-assisted learning.

We did not find disaggregated costs for the preparation of computer-marked assignments. Widely varying costs were quoted for interactive computer-marked assignments. Figures were given which range from about £300 up to £1 500 per student learning hour. An indicative figure of £900 may serve as a benchmark cost.

Where existing generic or specific software is bought in it usually needs to be incorporated into a course programme and consequently needs to be customised. A benchmark figure for such software customisation work is £150. Where extensive customisation is needed, with more software development costs, then the cost may rise to £2 000 to £8 000.

When databases have to be made available in searchable form, the data must be indexed and search tools have to be developed. Costs are consequently of two types: software development of search tools and the editing tasks of putting databases together and indexing them. The costs per student learning hour were estimated to be £150 for development of search tools and a further £150 for editing tasks. For a searchable database an indicative figure is therefore £300.

**Table 1.2: Computer-related costs**

	Cost range per student learning hour	Mid-point cost per student learning hour
Interactive computer marked assignments	300 to 1 500	900
Spreadsheet; packages		150
Searchable databases	Software input 150 Editing input 150	300
Computer assisted learning (CAL)	3 000 to 20 000	10 000
Multimedia CAL		20 000
Computer mediated communication (CMC)		100
Customisation of software	2 000 to 8 000	5 000

Source: own case studies

Benchmark figures for computer-assisted learning allowing simulation and modelling, are likely to be substantial. A benchmark figure would be £10 000 but figures of as high as £20 000 have been reported. These higher costs become more likely where film clips or other multimedia elements are included. Editing also becomes more complex so that additional editorial input ranges from £300 to £1 500. Thus the total cost of multimedia computer-assisted learning can be near to £30 000. (The costs we found are set out in table 1.2.)

We got mixed reactions from students about the use of CD-ROM. Some have reported that the use of interactive media slows the process of studying. There have been demands from students for printed copies of materials, as well as CD-ROM versions, because of their greater convenience. Students at a British Open University seminar, examining the use of computer technology, were however enthusiastic, some to the extent that they made further course choices dependent on the use of CD-ROM as a medium. The university has used CD-ROM for social science as well as natural science. One course, for example, on social investigation in nineteenth century Britain, used CD-ROM to provide students with a complete archive of the work of the 19th century social investigator Charles Booth both as handwritten original documents and in searchable digitised form.

Despite the wide range of costs reported, three conclusions are clear. First, in planning for the use of computer-based teaching, the manager needs to be very clear about the nature of the computer use proposed. If it is merely to provide a convenient means of distributing teaching material to students then, in principle, costs need be no higher than for print. In practice, however, course designers - and students - will expect to take advantage of the capacity that computers give for providing information in different ways. Development costs will then rise, and may do so dramatically. Second, the total cost of a programme using computer communication will be affected by decisions about the use of it for individual or group contact with students: we come back to this below in considering communication media. Third, unlike broadcasts, computer-based communication is unlikely to attract a wider student audience. The increased costs we have found will therefore need to be justified either in terms of the pedagogical benefits they bring.

We can now pull together the evidence on the fixed costs associated with each of our four sets of media. This is given in table 1.3. It shows the typical costs per student learning hour we found for the development of teaching materials in a range of media. As already proposed, we then have shown these as a multiple of the cost of preparing material in print, our proposed default option. The figures provide some basic guidance for the educational manager in estimating the investment required for various alternatives and, by implication, the critical importance of considering the size of the potential audience in relation to the choice of medium: the more students, the easier it is to justify moving away from the default option of print. To complete the resource-media picture we need next to look at the variable costs associated with each medium.

**Table 1.3: Resource media: fixed costs**

Currency: sterling

Media	Cost/SLH <sup>a, b</sup>	Cost/SLH as multiples of cost/SLH(print)
Print	350	x 1
Internet	700	x 2
Audio	1 700	x 5
CD-ROM	13 000	x 40
Video	35 000	x 100
TV	121 000	x 350

Source: case studies. Notes: a: cost/SLH stands for *cost per student learning hour*; b: costs here and in other tables, are in £sterling.

#### *Variable costs of resource media*

While the fixed costs for most resource media are of the greatest significance for the planner, some media also require expenditure on reproduction - as contrasted with development and production of a master version - and on distribution. These costs vary with the number of students. We have brought together exemplary figures in table 1.4.

In some cases, here, we have moved away from an attempt to cost everything in terms of student learning hours and instead used a standard unit, such as 48 pages of text or a single audiocassette in order to have a convenient and usable benchmark. In the case of open circuit radio or television we show distribution cost as zero on the assumption that transmission costs are met by a broadcasting agency and seldom fall as a charge on an educational institution. In the case of CD-ROM it is unrealistic to give a number of student learning hours per disc. A disc can, for example, provide for vastly more student learning hours if it simply contains text than if it consists of computer animations, music or film.

**Table 1.4: Resource media: variable costs**

Currency: sterling

	SLH	Unit	Reproduction cost per unit	Distribution cost per unit	Aggregate unit cost per unit
Print	10	48 pp	1.00	0.50	1.50
Radio	1	1 hour	none	none	none
Television	1	1 hour	none	none	none
Audio cassettes	1	C60	1.00	1.00	2.00
Video cassettes	1	E60	2.50	2.00	4.50
CD-ROM	vary	disc	3.00	1.00	4.00

Source: own case studies; production costs include labour and material costs.

## Costs for communication media

When we turn to communication media we are principally concerned with variable costs. For each bit of support offered to a student, or opportunity provided for dialogue, there is normally an additional cost, largely made up of the cost of tutorial time. In the case of technology-supported communication, for example videoconferencing or computer-based communication, there is also likely to be a cost for equipment and for line charges. But, for the manager, the vital point is that the costs here are ones that rise inexorably with the number of students. If the costs per student for communication media rise as high as the costs that would be required for face-to-face teaching, then open and distance learning can never have an economic edge over conventional teaching. Thus while these figures are in pounds and pence, not the hundreds or thousands of previous tables, they are costs that the manager critically needs to control.

In table 1.5 we set out some indications of the level of costs for communication that have been reported. In this table we have assumed that academic labour is paid at £25 per hour: readers in jurisdictions with very different salary levels would need to substitute figures here. In order to facilitate comparison, and make it realistic, table 1.5 sets out the costs for a notional course that has 5 hours of computer-mediated communication, 1 hour of videoconferencing, 8 hours of face-to-face tutorials and four assignments to be marked by a tutor.

**Table 1.5 Costs of communication media** Currency: Sterling

Communication media	Unit of inputs	No of units	Cost per unit	Formula and unit costs (variable cost per student)	Total unit cost
Computer-mediated communication	Hour of tutorial time	5	25	$\frac{\text{cost/UE}}{\text{groupsize}} = \frac{25}{20} = 1.25$	6.25
Video-conferencing	Hour of staff, depreciated equipment, line time	1	160	$\frac{\text{cost/UE}}{\text{groupsize}} = \frac{160}{20} = 8$	8.00
Tutorials	Hour of tutorial time	8	25	$\frac{\text{cost/UE}}{\text{groupsize}} = \frac{25}{20} = 1.25$	10.00
Tutor marked assignments	Assignment marked	4	12	Cost/UE = 12	48.00
<b>Total</b>					<b>80.25</b>

Note: UE = unit equivalent



We have calculated a cost for each unit and also assigned to it a number of student learning hours. In the case of a tutorial or a videoconference this is a realistic and useful measure. In other cases, however, it may be arbitrary or even misleading. A tutor-marked assignment, for example, may require ten hours work from the student. For the manager, however, the critical issue is not the length of time taken by the student but the amount of time the tutor spends marking it and therefore the unit cost per assignment. There is a further difficulty in estimating the cost per student learning hour for computer-mediated communication. In principle, it should be possible to ask tutors to spend one hour responding to the volume of computer communication generated by students in response to a particular section of a course, and pay the tutor accordingly. In practice tutors are unwilling or unable to confine their responses to computer communication or ration the time they devote to this part of their work. As a result, while in theory it may be possible for a tutor to respond in one hour to the work done by, say, twenty students in a computer conference in just the same way as might be possible in a videoconference or face-to-face, in practice tutors are likely to spend up to five times as long responding to computer communications.

Three other major - if obvious - points emerge from the figures. First, the marking of assignments has the highest unit cost as it is the only example in our table of one-to-one communication. Second, where there is an opportunity for group study, cost per student is very sensitive to the size of the group. We have assumed, for example, that a videoconference will attract an audience of twenty; if only ten come, the cost per student doubles. Third, because of the costs of equipment and line charges, tutoring that depend on electronic communication, such as videoconferencing, is likely to have higher costs per student than conventional face-to-face tutoring. It is likely to become more cost-efficient as more sites are included. However, there is a trade-off with effectiveness: the more sites are included, the more there is a tendency for a videoconference to turn into a one-way medium of communication. It may, however, have a potential advantage in some circumstances through savings of travel costs and the opportunity costs of the time students spend travelling.

## **Summary**

In the light of our case studies, and of existing data, we have drawn distinctions between resource media - the use of media to carry teaching materials to students - and communication media - allowing two-way interaction. In order to facilitate comparison between costs, especially of resource media, we have looked at the costs involved in providing for one student learning hour for each of the media on which we have data. Taking the cost of a text, and reproducing it in print, as a basis, or default option, the evidence shows that using any more sophisticated medium is likely to increase the development costs for resource media. In short, we need solid educational arguments for using anything other than print, and solid economic ones to justify our selection of media. To complete the cost picture we need to look at the reproduction and distribution costs for resource media and at the costs of communication media.

The figures demonstrate the importance, for the planner, of examining the educational case for using each medium other than print in making resources available for students, and of planning the amount of interaction between tutors and students that is to be built into the course, and offered through communication media. In the following four sections we examine ways of applying these lessons.

