4 How to apply it

The purpose of this chapter is to help make decisions about the choice of media for open and distance learning by applying the information and methods discussed so far. To do this we need to start with the benchmark cost data (table 1.2 to 1.5) and our understanding of the advantages and drawbacks of the different media available (tables 2.2 and 2.3). In doing so we need to consider the complementary roles of the course designer and the course manager (roles which may be combined in the same person). We can then look at the different stages of costing:

Decide how many student learning hours will be allocated to the available resource media in order to calculate their development costs.

Estimate the variable costs that will follow from this decision (e.g. the forecast production and distribution costs for a particular medium).

Determine the cost of student support, another variable cost.

All these figures can be brought together in one spreadsheet. This allows rapid cost forecasting and makes it possible to see the effects of changing our choice of media.

To put this discussion in context we then look at the cost of conventional teaching. Its cost structure provides a point of comparison by which to gauge the efficiency achievable with different choices of media. The chapter ends with a discussion of the kind of information and decisions needed in designing a course or programme that will be cost-effective.

Managers and educators

A major problem in addressing issues of cost-effectiveness is a cultural divide between managers and educators. Educators generally are more interested in quality and effectiveness and tend to consider economic issues as something outside their main area of concern (Coopers and Lybrand, 1996). In contrast, managers are more likely to be concerned with the allocation and use of resources and their costs. Table 4.1 lists some aspects of this difference. The manager needs to decide in the face of considerable contingencies, so that management decisions need to operate on a more abstract level in the interest of flexibility. We have argued that cost per learning hour is a suitable management tool which can guide cost-effectiveness decisions.

Table 4.1: Managers and educators: different roles

8		
	Manager/ administrator	Educator/ course designer
Focus of interest	Costs (inputs)	Academic achievement (outcomes)
Task and time orientation	Planning for the future	Implementation in the present
Level of attention	Attention to abstract structures	Attention to concrete details

Many educators have seen cost-effectiveness analysis as a method for research or evaluation rather than for academic planning. One tradition of research has involved investigating the choice of media in relation to their likely outcomes; educators have wanted to know how far a particular medium is likely to influence outcomes, whether measured in achievement scores or course completion rates. But, as we have already argued, comparison is seldom easy. While, in a good experimental situation, one would change educational strategies while keeping all other variables the same, this is seldom if ever possible when we are collecting field data. In our case we drew cost data from a widely differing set of environments - from the use of print and videocassettes for the inservice education of primary-school teachers in Norway to the use of the Internet for international professional education. We were encouraged in using this data by our desire to look at cost-effectiveness from a managerial point of view; which drove us to our concentration on cost per student learning hour.

From the educator's perspective the indicator of cost per student learning hour appears to be crude. In this section our aim is to show how the exchange between course designer (leaning more towards the educator's position) and course manager could become a process which would improve cost-effectiveness. It is a process in which pedagogic requirements can be taken into account while at the same time their cost implications are kept visible.

Estimating the costs of media choice

To estimate the costs of media for a particular course we start by asking how the planned number of student learning hours will be allocated to each of the different media available. Here pedagogical considerations can play a part: we have to balance one-way presentation of content and active engagement by the learner. This kind of engagement can be achieved by means of either internal or external interactivity. We need then to look separately at the costs of resource media and of communication media, and go on to identify fixed and variable costs. These make it possible to evaluate the total and average cost functions for any level of enrolment.

Distributing student learning time

Before a course is planned in detail, decisions are needed about its length and level which together determine the number of student learning hours. These decisions are often outside the control of an individual course manager or course writer. The designated number of student learning hours, required to teach the subject matter, set the upper boundary for the number of hours to be allocated to media; some hours are likely to be attributed to individual, private, work by the student which has no cost implications for the teaching institution.

In chapter two we presented two tables, which provide a possible format for the distribution of student learning hours against the different media (tables 2.2. and 2.3). Table 2.2 lists the media (breaking down the features of computer-based teaching) against the headings of presentation, internal and external interactivity. The shaded areas indicate the media (horizontal entries), which have particular advantages for a given teaching feature (vertical entries). Its layout allows us to monitor the balance between one-way instruction (presentation of content) and more active learning features. The distribution of the shading suggests, for example, the strengths of computer media to support internal interactivity. Several formats to link media capabilities to teaching functions have been proposed (Laurillard, 1993); a simple version is presented in table 2.3. The point here is not to advocate one specific format but to argue that in the process of media selection such formats can facilitate a monitoring process (e.g. by indicating the proportions of learning time devoted to the presentation of teaching material and to dialogue among students or with tutors) and keep the media options visible.

In both tables (table 2.2 and 2.3) the horizontal subtotals (summarised in the last column to the right) are important for the next step. By showing the amount of time allocated to each medium they provide the starting points for costing the inputs of both resource media and communication media.

Calculating the resource-medium costs

In order to calculate cost per student learning hour for resource media, medium by medium, we need to take account of both their fixed costs - often predominantly development costs - and the variable costs that follow from the choice of any one medium. We know for instance that the choice between television and videocassettes depends partly on the variable cost that is incurred for each student if videocassettes have to be manufactured and distributed. The higher development cost per student learning hour of broadcast television may be outweighed by its lack of variable costs, and insensitivity to increasing student numbers (A.W. Bates, 1995).

In table 4.2 we set out some exemplary costs for the resource media used in a notional course, using print, radio and some computer-based teaching. The actual figures used are indicative, and are based on our case studies. These are all fixed costs, for the development of teaching to provide the number of student learning hours shown against each medium.

Table 4.2: Ready reckoner for resource media Currency: Sterling									
Resource media	Student learning hours	Unit equivalents	Cost per unit	Fixed costs					
	SLH	UE	Cost/UE	£					
Print	150	15 ^h	3 500	52 500					
Radio	1	1	20 000	20 000					
Television	0	0	120 000	0					
Audio	0	0	1 700	0					
Video	0	0	35 000	0					
Computer-based teaching	1								
Hypertext ^a	20	20	700	14 000					
Computer-marked assignments (CMA) ^b	5	5	100	500					
Interactive CMA ^c	20	20	1 100	22 000					
Computer tools ^d	0	0	250	0					
Computer-searchable databases ^e	0	0	150	0					
Computer-assisted learning $(CAL)^{f}$	0	0	11 500	0					
Multi media CAL ^g	15	15	12 000	180 000					
Total	211			289 000					

Table 4 2. Ready reckoner for resource media

Notes: a: a text document with links to other text documents; b: generally in multiple-choice format and used mainly for tests; c: the program evaluates the learner's response and may then present new questions or hints about solutions to a problem; d: generally involving the use of software (e.g. spreadsheets) available on the market; e: often using generic software; copyright often needs to be cleared for documents included within the database; f: an umbrella term for interactive approaches which vary widely in their complexity; g: likely to include sounds and film clips, thus incurring designs as well as programming costs; h: 1 UE print = 50 pages = 5 SLH

We can now go on to incorporate into our planning the variable costs that will follow from our decision to choose a particular teaching medium. In order to do this we have translated the number of student learning hours into units (or unit equivalents, UE) specific for each medium. The UE for print is defined as 50 pages of print and is taken as providing for ten student learning hours; the unit equivalents for cassettes are C60 and cassettes. The unit equivalent for learning resources delivered on

CD-ROM is a disc. If we know the number of these unit equivalents it is possible to calculate the variable cost per student, as shown in table 4.3.

The costs we use for reproduction and distribution of the respective unit equivalents are necessarily crude: a student learning hour of audiocassette can, for example, be provided as one C60 or two C30 cassettes. If data are integrated in a spreadsheet, modifications to take account of actual or changing costs are easily made. The point here is not to demonstrate actual cost but to prepare a spreadsheet, which allows customisation to different contexts.

Table 4.3: Ready reckoner for the induced variable costsCurrency: Sterling									
			Variable cos	t per stud	lent of				
Resource media			Replication	I	Distribution		Total		
	SLH	UE	Cost/UE	Total	Cost/UE	Total			
Print	150	15	1.00	15.00	0.50	7.50	22.50		
Radio	0	0							
Television	0	0							
Audio	0	0	1.00	0	1.00	0	0		
Video	0	0	2.50	0	2.00	0	0		
Computer-based teaching									
Hypertext	10	10		ĺ					
Computer-marked assignments (CMA)	5	5							
Interactive CMA	20	20							
Computer tools	0	0							
Computer-searchable databases	0	0							
Computer-assisted learning (CAL)	0	0							
Multi media CAL	15	15							
CD-ROM (Subtotal)		1	3.00	3.00	1.00	3.00	4.00		
Total							26.50		

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Source: own case studies

Calculating the communication-medium costs

We need a different approach in considering the cost of communication media. Here we are less concerned with the cost per student learning hour than with the cost, of providing for interaction with the student, that falls on the institution. In examining tutorial costs, for example, the educational manager needs to know how much time will be spent by the tutor, and so the size of the bill for tutors' pay, and is less concerned with the amount of time spent by the student. For this reason we suggest that the manager should develop a set of unit equivalent costs for communication media. In table 4.4 we set out some exemplary costs. We need to take account of three elements in calculating these unit costs. First, the cost of tutorial time which we can assume will be at the same hourly rate regardless of the medium used. Second, for electronic media like telephone-based teaching or videoconferencing, we may have equipment costs and line charges. Third, we may need to consider how face-to-face tutoring is provided. With the exception of the marking of assignments, student support is often provided to groups of students rather than to individuals so that, to derive a unit cost, we need to divide the total cost by the average number of students in a group.

Communication media	Unit equivalents (UE) of inputs	No of UE	Cost/ UE	Formula and unit costs (i.e. variable cost per student)	Total unit cost contribution
Computer- mediated communication	Hour of tutorial time	5	25.00	$\frac{\text{cost/UE}}{\text{group size}} = \frac{\pounds 25}{20} = \pounds 1.25$	6.25
Video- conferencing	Hour of staff, depreciated equipment, line time	1	160.00	$\frac{\text{cost/UE}}{\text{group size}} = \frac{\pounds 160}{20} = \pounds 8$	8.00
Telephony	Fraction of tutor time and line time	1	8.00	$\frac{\text{cost/UE}}{\text{group size}} = \frac{\pounds 8}{20} = \pounds 0.4$	8.00
Tutorials	Hour of tutorial time	8	25.00	$\frac{\text{cost/UE}}{\text{group size}} = \frac{\pounds 25}{20} = \pounds 1.25$	10.00
Tutor-marked assignments	Assignment marked	4	12.00	$Cost/UE = \pounds 12$	48.00
Total					80.25

Table 4.4: Ready reckoner for unit cost contribution of communication media

Currency: Sterling

Table 4.4 summarises decisions on the amounts of communication media and sets out the unit cost calculated for each medium as a consequence of these decisions. The total variable costs for staff support have to be added to the variable costs of the resource media in order to complete the picture of the costs for a given course. The example presented in tables 4.3 and 4.4 gives us a total variable cost of £106.75 made up of £26.50 for the cost for resource media and £80.25 for communication media and student support.

Putting it all together

From tables 4.2 to 4.4 we can now calculate the total and average costs for different levels of enrolment. Table 4.5 puts the data together and calculates the costs for different levels of enrolment.

Table 4.5: Total and a	Curre	Currency: Sterling		
		Leve	el of enrolmer	nt
	Cost functions	Low	Medium	High
Student number		1 000	5 000	10 000
Total cost function $TC = F + V \ge s$	TC=289 000+106.75 x s	395 750	822 750	1 356 500
Average cost AC = F/s + V	AC=(289 000/s)+106.75	396	165	136

We will integrate all the different tables (table 4.3 to 4.4) in a unified spreadsheet (see table 4.6), which easily allows modification and keeps the cost dimension visible during the process of media selection.

	Student	Unit	Cost per	Fixed Variable c		cost per stude	entof	Total unit
	learning hours	equi valents	unit	costs	communication	production	distribution	costs
Resource media	SLH	UE	per UE	£		£	£	£
Print	150	15	3500	52500		1,0	0,5	22,5
Radio	0	0	20000	0				
Television	2	2	120000	240000				
Audio	5	5	1700	8500		1,0	1,0	10,0
Video	12	12	35000	420000		2,5	2,0	54,0
Computer-based teaching								
Hypertext	20	20	700	14000				
Computer-marked assignments (CMA)	4	4	100	400				
Interactive CMA	6	6	1100	6600				
Computer tools	20	20	250	5000				
Computer-searchable databases	15	15	150	2250				
Computer-assisted learning (CAL)	7	7	11500	80500				
Multi media CAL	3	3	12000	36000				
CD-ROM (Subtotal)	75	2				3,0	1,0	8,0
Communication media			per hour					
Computer-mediated communication	12	12	25,0		15,0			
Videoconferencing	3	3	160,0		6,0			
Tutorials	8	8	25,0		10,0			
Tutor-marked assignments	40	4	12,0		48,0			
Unit cost (Subtotals)					79,0	7,5	4,5	94,5
Total	307			865750				173,5
					enrolment level:	low	medium	high
Students						1000	5000	10000
Total costs						1039250	1733250	2600750
Average costs						1039	347	260

Table: 4.6: A simplified spreadsheet

Modifying the media selection

Media selection can be an iterative process. A first plan of a course is drafted and its cost estimated. Modifications are made and their cost implications estimated. For this purpose a spreadsheet, which integrates the information collected on cost per student learning hour of resource media, their variable costs, and the unit costs for communication media, is helpful in facilitating a rapid cost appraisal.

Table 4.6 represents such a spreadsheet. It integrates the tables (4.2 to 4.5) and feeds the results into an equation of total and average costs.

Table 4.6 uses all media and includes a variety of different types of computer-based teaching, purely as an illustration. Such a wide choice is highly unlikely in practice, not only because it leads to unsustainably high costs; we chose to include all media in order to make the working of the spreadsheet clear.

In looking at the distribution of rows in the spreadsheet we can see that the first set of rows shows the *resource media*. In the case of print, audio- and videocassettes we have both fixed costs of development and variable cost of reproduction and distribution. The fixed costs per learning hour (or cost per unit equivalent) are taken from table 4.2. Similarly, the unit cost of reproduction and distribution are taken from table 4.3. Television and radio have no variable cost per student. This applies also for computer-based teaching if it is made available over the Internet (downloading costs are marginal and neglected here; in this context we also chose to ignore reception costs).

We may also choose to distribute computer-based teaching material on CD-ROM. In this case variable costs are incurred. Our spreadsheet display indicates costs of digitised features in more detailed breakdown, in which case we have no fixed costs against the heading CD-ROM. Alternatively we may aggregate the digitised features and put a figure against CD-ROM. In each case we have unit costs for reproduction and distribution.

The second set of rows in table 4.6 relates to *communication media*, showing cost per hour of input rather than per hour of student learning time.

Looking next at the columns, we can see that the second column summarises the manager's allocation of student learning hours to particular media.

The third column shows student learning hours in unit equivalents on the lines discussed above (10 student learning hours print are shown as equivalent to 50 pages, which we treat as a unit (unit equivalent). The unit equivalents are packages of SLH which, in the case of resource media, correspond to material objects like books, tapes or discs. The production and distribution of such teaching materials generate variable costs. In all cases other than print and CD-ROM the unit equivalent is equal to a student learning hour. The unit equivalent of one student learning hour audio is a C60 cassette. The reproduction and distribution costs relate to the cost of the cassette, the production cost of copying and the distribution costs. These costs are summarised in the last column.

The cost per unit column refers to cost per unit equivalent in the case of resource media and to cost per hour of input for communication media.

In the lower part of the spreadsheet student numbers can be entered, making it possible to calculate total as well as average costs. As an illustration we show total and average costs for low, medium and high enrolment for the given choice of media.

Application of the spreadsheet

Spreadsheets of this kind can be used for the rapid appraisal of costs and to estimate the consequences of changes to course design. We start by calculating a low cost option, which is used as default option. This is a print-based option, complemented by a minimum of support through tutor-marked assignments and face-to-face tutorials. The data on the costs of media suggest that this likely to be the most cost-effective option, provided we leave out of our calculation questions of motivation, and completion rates that may depend on it. Thus, this option is likely to be the least-cost option as measured in terms of cost per student. It may not be the least-cost option if we measure in terms of successful students.

As an example we consider a 30 CAT point course. We opt for a level of media support of about 200 to 250 SLH (including tutor-marked assignments). The course is entirely print-based with a minimum of face-to-face tuition (four sessions). Four assignments are required. The average cost is set against a projected enrolment of 1 000, 5 000 or 10 000 students. Table 4.7 sets out the costs for this option.

The spreadsheet allows us to instantly investigate variations: what will happen when we increase the standard student support, say from four to eight tutorials? The variable cost will increase from £83 to £88 and this in turn will increase average costs (for 5 000 students we see an increase from £97 to £102; table 4.8; *modification 1*). If we wanted to compensate for the four hours increase in tuition, we would have to double the enrolment; with 5 000 students and rather low fixed costs the scale economies are already largely exhausted.

In *modification* 2 we have changed the choice of media, by introducing 15 hours of audio and 5 hours of video, something that might be appropriate for a language course. Print costs have been reduced slightly but tutorial costs maintained at 8 hours. The results are set out in table 4.9. With the increased fixed costs for audio and video, the cost per student more than doubles at an enrolment of 1 000. At the same time the high difference between the aggregated unit costs and the average costs signal room for economies: raising the enrolment level to 5 000 we can cut average costs by more than a half.

Television can be a powerful means to advertise a course and perhaps increase enrolment. If two hours (or about six 20-minute slots) of television were introduced in place of the video component, the average costs would rise if the low enrolments were unchanged. But if the increased level of publicity doubled the enrolment to 2 000 over the lifetime of the course we would have an average cost level of

£274 and would have compensated for the increased fixed cost of television (table 4.10; *modification* 3).

We can also look at the effect of introducing computer-based teaching rather than audio and video or television. In order to develop material to support 60 SLH with CD-ROMs we would need an investment of £216 500. As table 4.11; *modification* 4, shows this would give a relatively high average cost, at £391 per student with an enrolment of 1000 as compared with a figure of £153 for the default option. But there are potential economies of scale here: with an enrolment of 5000 (which might be spread over a number of years) the cost comes down to £160 per student compared with £97 for the default option. An educational as well as an economic judgement will be needed as to whether the increased cost over the default option is justifiable in terms of any increase in educational quality. (We said that quite often the number of CD-ROM discs is a matter of convenience rather than of the space available on them. If we could use only one instead of five discs we would end up with average costs reduced by more than £10.)

The discussion demonstrates the value of spreadsheet facilities to keep costs visible while discussing the media options. They could, of course, be much more detailed without being much more difficult to operate. Benchmark data to be included in them would need to be customised to fit the circumstances of a particular institution. The figures here are indicative (i.e. based on real world figures) but not necessarily representative (i.e. based on systematic sampling). But with a system of this kind the cost implications of media decisions can be at the manager's fingertips.

	Student	Unit	Cost per	Fixed Variable of		cost per stude	cost per student of		
	learning hours	equi valents	unit	costs	communication	production	distribution	costs	
Resource media	SLH	UE	per UE	£		£	£	£	
Print	200	20	3500	70000		1,0	0,5	30,0	
Radio	0	0	20000	0					
Television	0	0	120000	0					
Audio	0	0	1700	0		1,0	1,0	0,0	
Video	0	0	35000	0		2,5	2,0	0,0	
Computer-based teaching									
Hypertext	0	0	700	0					
Computer-marked assignments (CMA)	0	0	100	0					
Interactive CMA	0	0	1100	0					
Computer tools	0	0	250	0					
Computer-searchable databases	0	0	150	0					
Computer-assisted learning (CAL)	0	0	11500	0					
Multi media CAL	0	0	12000	0					
CD-ROM (Subtotal)		0				3,0	1,0	0,0	
Communication media			per hour						
Computer-mediated communication	0	0	25,0		0,0				
Videoconferencing	0	0	160,0		0,0				
Tutorials	4	4	25,0		5,0				
Tutor-marked assignments	40	4	12,0		48,0				
Unit cost (Subtotals)					53,0	7,5	4,5	30,0	
Total	244			70000				83	
					enrolment level:	low	medium	high	
Students						1000	5000	10000	
Total costs						153000	485000	900000	
Average costs						153	97	90	

Table: 4.7: Default option (Print based)

	Student	Unit	Cost per	Fixed	Variable	cost per stude	ent of	Total unit
	learning hours	equi valents	unit	costs	communication	production	distribution	costs
Resource media	SLH	UE	per UE	£		£	£	£
Print	200	20	3500	70000		1,0	0,5	30,0
Radio	0	0	20000	0				
Television	0	0	120000	0				
Audio	0	0	1700	0		1,0	1,0	0,0
Video	0	0	35000	0		2,5	2,0	0,0
Computer-based teaching								
Hypertext	0	0	700	0				
Computer-marked assignments (CMA)	0	0	100	0				
Interactive CMA	0	0	1100	0				
Computer tools	0	0	250	0				
Computer-searchable databases	0	0	150	0				
Computer-assisted learning (CAL)	0	0	11500	0				
Multi media CAL	0	0	12000	0				
CD-ROM (Subtotal)		0				3,0	1,0	0,0
Communication media			per hour					
Computer-mediated communication	0	0	25,0		0,0			
Videoconferencing	0	0	160,0		0,0			
Tutorials	8	8	25,0		10,0			
Tutor-marked assignments	40	4	12,0		48,0			
Unit cost (Subtotals)					58,0	7,5	4,5	30,0
Total	244			70000				88,0
					enrolment level:	low	medium	high
Students						1000	5000	10000
Total costs						158000	510000	950000
Average costs						158	102	95

Table: 4.8: Modification 1 (Increasing tutorial support)

	Student	Unit	Cost per	Fixed Variable		cost per stude	Total unit	
	learning hours	equi valents	unit	costs	communication	production	distribution	costs
Resource media	SLH	UE	per UE	£		£	£	£
Print	180	18	3500	63000		1,0	0,5	27,0
Radio	0	0	20000	0				
Television	0	0	120000	0				
Audio	15	15	1700	25500		1,0	1,0	30,0
Video	5	5	35000	175000		2,5	2,0	22,5
Computer-based teaching								
Hypertext	0	0	700	0				
Computer-marked assignments (CMA)	0	0	100	0				
Interactive CMA	0	0	1100	0				
Computer tools	0	0	250	0				
Computer-searchable databases	0	0	150	0				
Computer-assisted learning (CAL)	0	0	11500	0				
Multi media CAL	0	0	12000	0				
CD-ROM (Subtotal)		0				3,0	1,0	0,0
Communication media			per hour					
Computer-mediated communication	0	0	25,0		0,0			
Videoconferencing	0	0	160,0		0,0			
Tutorials	8	8	25,0		10,0			
Tutor-marked assignments	40	4	12,0		48,0			
Unit cost (Subtotals)					58,0	7,5	4,5	79,5
Total	248			263500				137,5
					enrolment level:	low	medium	high
Students						1000	5000	10000
Total costs						401000	951000	1638500
Average costs						401	190	164

Table: 4.9: Modification 2 (Introducing video and audio components)

	Student	Unit	Cost per	Fixed	Variable	cost per stude	ent of	Total unit
	learning hours	equi valents	unit	costs	communication	production	distribution	costs
Resource media	SLH	UE	per UE	£		£	£	£
Print	180	18	3500	63000		1,0	0,5	27,0
Radio	0	0	20000	0				
Television	2	2	120000	240000				
Audio	15	15	1700	25500		1,0	1,0	30,0
Video	0	0	35000	0		2,5	2,0	0,0
Computer-based teaching								
Hypertext	0	0	700	0				
Computer-marked assignments (CMA)	0	0	100	0				
Interactive CMA	0	0	1100	0				
Computer tools	0	0	250	0				
Computer-searchable databases	0	0	150	0				
Computer-assisted learning (CAL)	0	0	11500	0				
Multi media CAL	0	0	12000	0				
CD-ROM (Subtotal)		0				3,0	1,0	0,0
Communication media			per hour					
Computer-mediated communication	0	0	25,0		0,0			
Videoconferencing	0	0	160,0		0,0			
Tutorials	4	4	25,0		5,0			
Tutor-marked assignments	40	4	12,0		48,0			
Unit cost (Subtotals)					53,0	7,5	4,5	57,0
Total	241			328500				110,0
					enrolment level:	low	medium	high
Students						1000	5000	10000
Total costs						438500	878500	1428500
Average costs						439	176	143

Table: 4.10: Modification 3 (Shifting to using television)

	Student	Unit	Cost per	Fixed	Variable	cost per stude	ent of	Total unit
	learning hours	equi valents	unit	costs	communication	production	distribution	costs
Resource media	SLH	UE	per UE	£		£	£	£
Print	150	15	3500	52500		1,0	0,5	22,5
Radio	1	1	20000	20000				
Television	0	0	120000	0				
Audio	0	0	1700	0		1,0	1,0	0,0
Video	0	0	35000	0		2,5	2,0	0,0
Computer-based teaching								
Hypertext	20	20	700	14000				
Computer-marked assignments (CMA)	5	5	100	500				
Interactive CMA	20	20	1100	22000				
Computer tools	0	0	250	0				
Computer-searchable databases	0	0	150	0				
Computer-assisted learning (CAL)	0	0	11500	0				
Multi media CAL	15	15	12000	180000				
CD-ROM (Subtotal)	60	5		216500		3,0	1,0	20,0
Communication media			per hour					
Computer-mediated communication	5	5	25,0		6,3			
Videoconferencing	0	0	160,0		0,0			
Tutorials	4	4	25,0		5,0			
Tutor-marked assignments	40	4	12,0		48,0			
Unit cost (Subtotals)					59,3	7,5	4,5	42,5
Total	260			289000				101,75
					enrolment level:	low	medium	high
Students						1000	5000	10000
Total costs						390750	797750	1306500
Average costs						391	160	131

Table: 4.11: Modification 4 (Using CBT components)

Comparing with lecturing

Institutions may have different benchmarks to assess their performance. At the institutional level, economic comparisons are usually made in terms of cost per student or cost per graduate. Policy makers and institutions are often interested in the comparative costs of open and distance learning and of conventional education. We can use the approach discussed so far to compare the cost structure of conventional lecturing with the default option calculated above.

In order to calculate the cost of conventional teaching we need to know the staffing cost, or cost per contact hour, the number of contact hours, and the number of students in a group. (In the following example we use the term 'lecturing' to cover both formal lectures and seminars or tutorials.) We assume that a lecture has to be repeated if the number of students exceeds a specified group size. Thus, if we set the maximum group size as twenty and have 155 students, it is necessary to repeat a class or lecture eight times. As a result the total cost for lecturing is the cost for each lecture multiplied by the number of lectures or contact hours in a series of classes, multiplied by the number of repetitions. This gives us the following equation:

TC(Lecturing) = (lecturing cost per hour x contact hours) x no of repetition s

where : no of repetition $s = \left[\frac{\text{students}}{\text{group size}}\right]$

Therefore we have:

TC(Lecturing) = (lecturing cost per hour x contact hours) $x \left[\frac{\text{students}}{\text{group size}} \right]$

In order to determine the average costs of lecturing we have to divide the total cost of lecturing by the number of students.

 $AC(\text{Lecturing}) = \frac{\text{TC}(\text{Lecturing})}{\text{students}}$ $= \frac{(\text{lecturing cost per hour x contact hours}) \text{ x} \left[\frac{\text{students}}{\text{group size}}\right]}{\text{students}}$

This leads to the final equation:

 $AC(Lecturi ng) = \frac{lecturing \ cost \ per \ hour \ x \ contact \ hours}{group \ size} = constant$

This is an important observation. It means that if we identify the costs of conventional education with the costs of lecturing (an admitted simplification), then the representation of such costs as graphs are straight lines parallel to the x-axis: there are no economies of scale open to us. They are very much like the unit cost term in their graphic representation of the average cost of distance education courses. (While this holds true, there are two complications which we would need to bear in mind in making any real comparison. First, the group size for a lecture is likely to be greater than the group size for a seminar. One way of reducing the cost per student in conventional calculation is to shift the balance between lectures and seminars. Second, seminar group size is not fixed. Anecdotal evidence suggests that, in England for example, it has risen in recent years. This process has been described both as efficiency gain and as erosion of quality.)





Notes: average costs are in £; the arrow indicates the break-even point with lecturing.

Figure 4.1 represents the graph of the average cost function of a distance education course (AC = F/s + V). It drops down towards a line parallel to the x-axis. This line represents the constant term in the average cost function (i.e. the variable cost per student V). In other words, if the variable costs of open and distance learning (for such activities as reproducing and distributing course materials and providing tutorial support) are greater than the constant cost of enrolment.

If the lecturing costs are above this level but the difference is small, then we have to determine the break-even point. It may well be that the break-even point is beyond the probable level of enrolment.

We can now compare a default option with an alternative delivered conventionally. Since for the default option above we assumed a 30 CAT point course of 300 student learning hours, we do the same for the lecturing alternative. Some institutions have reported as a rule of thumb that 30 CAT points will be supported by 45 contact hours.

The acceptable group size for a seminar varies but to begin with we assume a group size of 15 students.

The cost of a lecturer per hour also varies between institutions and even more so between countries. However, since these variations are not the focus of discussion here, we base our comparison on the cost per hour of a senior lecturer on a mid-point in salary in higher education in England (1997). Even then there is some variation. Lecturers have teaching obligations and are required also to undertake research. As we saw, the cost per hour varies depending on the extent to which the research obligations are taken into account. Similarly the way in which overheads are to be taken into account varies. The table 4.12 indicates the resulting range of costs per hour.

If we take overheads into account at 40% but ignore research obligations and insert these data into the above formula, we get:

 $AC(Lecturing) = \frac{\text{lecturing cost per hour x contact hours}}{\text{group size}} \Rightarrow$ $AC(Lecturing) = \frac{\pounds 71 \text{ x } 45}{15} = \pounds 213$

Table 4.12: Cost of lectu	ring	Currency: Sterling			
Research considered at	Number of Hours	Plain Payroll	PP + 40% overheads		
		(for £28 000 per year)	(£39 200 per year)		
		Per hour	Per hour		
0%	550	51.00	71.00		
35%	846	33.00	46.00		
50%	1 100	25.00	36.00		

Note: this table takes as its starting point the assumption in case study 7 that a lecturer teaches 550 hours a year and examines the effect on teaching costs about decisions to attribute costs entirely to teaching or partly to teaching and partly to research.

To compare lecturing with the default option for a distance education course we check first if the necessary condition for the greater efficiency of distance education is satisfied: The lecturing costs

must be lower than the aggregated unit costs. Since 92 < 213, this condition is satisfied. Therefore it makes sense to determine the break-even point.

The break-even point is determined by finding the intersection point of the two respective graphs. Algebraically, we have to solve the equation AC(Lecturing) = AC(s) for s.

$$AC(\text{Lecturing}) = AC(s) \Rightarrow \pounds 214 = \frac{\pounds 70\ 000}{s} + \pounds 92 \Rightarrow$$
$$\pounds 214 - \pounds 92 = \frac{\pounds 70\ 000}{s} \Rightarrow \pounds 122 = \frac{\pounds 70\ 000}{s} \Rightarrow$$
$$s = \frac{\pounds 70\ 000}{\pounds 122} = 574$$

This means s = 574 is the break-even point: with more than 574 students enrolled the average cost of the distance teaching alternative provides lower average cost and can be said to be more cost-efficient. The arrow in figure 4.1 indicates the break- even point.

Next, we need to look at the effect of changing group size. Table 4.13 looks at the effect of changing group size on the break-even point between open and distance learning and lecturing.

While increasing the class size has a considerable effect on the break-even points, in all cases the variable cost of our default option (print-based distance education) is competitive with lecturing. In all cases the necessary condition of potential cost-efficiency is satisfied: in all variations, the average cost per student of courses delivered by lecturing is above the variable cost per student of the distance-teaching option.

Table 4.13: A sensitivity analysis		Currency: Sterling
Based on £46 as cost per hour per lecturer	Class size	Break- even point
AC Lecturing = 138	15	1 522
AC Lecturing $= 104$	20	5 833
AC Lecturing = 83	25	none

This is illustrated in Figure 4.2. The break-even points are indicated with arrows. The lower the average cost per lecturing, the further to the right is the break-even point. In this case they remain within the likely level of enrolment we have specified.



Figure 4.2: Sensitivity analysis

Information, calculation, decision

We can now summarise what information is needed in order to use cost-effectiveness analysis to help course planning and how the information can be used.

The manager needs two sets of basic information. The first set is derived from decisions about the scale, level and weighting of a course. We have suggested that the total number of student learning hours is likely to be the key variable here. The second set comprises information about the costs of different kinds of teaching. We have suggested that it is useful to develop a set of benchmark costs for the fixed and variable costs likely to be incurred for different media.

Next, critical decisions have to be taken about the breakdown of student learning hours between teaching that is provided by the institution, individual study time, and the amount of time to be allocated to resource media, providing instruction, and communication media, permitting dialogue.

Once this information is gathered and these decisions are taken, a number of inferences can be drawn about the costs to be expected for particular levels of enrolment and combinations of media. Table 4.14 sets out the parameters involved. The approach discussed in this chapter, and the kind of spreadsheets discussed, are designed to help in their examination and analysis.

	Information	Decision to be	Inferences to be
	required	taken	made
No of SLH	Х		
No SLH to be supported by media		Х	
By resource media		Х	
By communication media		Х	
Costs per input			
Cost/SLH(resource medium)	Х		
Unit cost/resource medium	Х		
Cost/SLH(communication medium)	Х		
Total costs			
Total fixed costs			Х
Total unit costs			Х
Student number	Х		
Total costs			Х
Average costs			Х

Table 4.14: Relevant parameters