

### **3 Why these things are difficult to interpret**

Our work, and that of others, makes it possible to say how much different educational technologies are likely to cost, and how these costs will vary. But there are both conceptual and practical difficulties in applying these findings. We need to look at these before moving on.

#### **Conceptual difficulties**

We start with the problems inherent in any attempt to measure learning and go on to examine how far the costs of individual media can be separated out from each other in determining the cost per student learning hour. Finally, we comment on the conceptual problems of measuring the costs of individual media when using cost per student learning hour as our indicator.

#### *Media and learning*

Economists have argued that it is sometimes useful to treat education as a system in which you can optimise input/output relationships and develop an 'education production function' (Hanushek in Carnoy (ed.), 1995). The purpose of the approach is to facilitate comparison between measurable inputs to and outputs from the educational process. Following this approach we can try to examine how the input parameters affect performance in terms of outcomes, and seek to draw management guidelines from these calculations.

Changes in input parameters might, for example, include more books, better teacher training, and longer school hours. But it is not as simple as that. Educators rightly point out that results depend on what you do during these school hours, on the quality of the books, and on the content of the teacher training. The economic approach tends to disregard this: it is assumed that books, teacher training and other inputs live up to the standards of the educational requirements, and economic analysis does not require a qualitative appraisal.

Our approach resembles a production function in seeing media as machines which produce learning time with varying efficiency. Educators may quite properly object that learning effectiveness depends on how this time is used. There are, however, both practical and theoretical arguments for disregarding this qualitative issue. The practical arguments follow from the fact that we rarely have data that give us any information on the quality of learning or that relate this to a particular medium. The theoretical arguments follow from the assertion that, in the absence of evidence favouring one medium over another, it is reasonable to take the time spent in learning from any one medium as equivalent to learning from another. Thus we can with some legitimacy use a measure of learning time, and of the costs of the media used to provide it, as a proxy measure for cost-effectiveness. It is a better measure than anything else available.

Educators might further question if the study time created by each such machine is equivalent (as the media equivalence hypothesis suggests). It might be that learners' progress depends on individual differences in the style of learning or on the appropriateness of a medium for a particular task. We know that there are practical advantages for certain media which lead to their choice for particular functions. Recognition of objects, for example, can be triggered more swiftly by visual than by linguistic cues. (A detective will show around pictures to identify a suspect and not distribute descriptions. A scuba diving course will give divers an account of the fauna to be observed, using coloured identification charts, rather than lengthy descriptions.) This problem can be seen as the tension between the media equivalence hypothesis and the argument that media have different capabilities. We want to give this a new interpretation.

Education, as we know it, is predicated on written language. There is no science and no recorded literature before writing. Even academic oral language is based on writing. One reason for the fact that the choice of medium makes little or no difference to learning is that most media are able to communicate written language either as speech or as text. Written language is the great equaliser across the media. Furthermore, assessment is usually based on text. Learning which cannot be expressed in language is likely to be ignored in many tests or attempts to measure learning and finds little expression in effectiveness scores.

Almost all media make it possible to communicate conceptual language either in speech or in writing. A medium which cannot carry conceptual language does not qualify as educational medium. (A point in case are computer games: indeed children may learn a lot in computer games but much of what they learn is not measured by current assessment systems (Greenfield, 1984)). The 'no significant difference' findings (Russell, 1997) may flow, in part, from the fact that the experiments, like much education, ultimately depend on text.

The approach we propose is not a production function approach, which would result in recommending a specific set of inputs (a particular combination of media, in our case) to be favoured over the others. What we advocate is a framework, which identifies media, and examines their efficiency in creating learning time.

The conceptual difficulty here is to steer between ignoring effectiveness issues altogether (because they are too complex) and getting entangled in them (for the same reasons). In order to do this we have avoided any attempt to link the choice of medium directly to outcomes. As we have seen, without costly and lengthy research, that attempted to compare combinations of media rather than single media, and to do so in the field rather than the laboratory, we have no grounds for arguing that particular combinations are likely to increase or improve educational outputs. Instead, we have concentrated on costs, suggesting ways in which the manager can predict costs per student learning hour for a particular medium, and leaving as an educational decision the choice of medium for a particular task.

*The framework of credit accumulation and transfer points (CAT points)*

In concentrating on student learning hours we are encouraged by the fact that learning time is already used to measure achievement. In order to make degrees comparable across Europe a framework of credit accumulation and transfer is emerging. This associates degrees (and, by inference, their components) with time spent studying, in numbers of years, terms or semesters. It goes without saying that it is supposed that certain standards of quality are adhered to. But rather than attempting to compare a diversity of curricula, learning time is taken to provide the benchmarks. The credit accumulation and transfer scheme depends on a relationship between CAT points and student learning hours (SLH).

Table 3.1 indicates that the majority of institutions in England and Wales tend towards a ratio of ten SLH to one CAT point. (Negotiations about the acceptance of a universal framework of credit transfer and accumulation are still under way.)

**Table 3.1: Number of learning hours corresponding to 120 CAT**

Percentage of institutions (sample size=67)	10%	32%	54%
SLH per year (for FTE student)	1 080	900 - 960	1 200
SLH per week (over 30 weeks)	36	30	40

Source: based on HEQC; sample taken from institutions in England and Wales.

The relationship between CAT points and learning time assumes that general criteria of good practice are satisfied, and that the time spent with an institution is properly assessed. Given those conditions it demonstrates the willingness of institutions to treat student learning hours in practice as a proxy indicator to compare degrees and what they should refer to - achievements in learning.

Some difficulties do, however, remain. Not only is there still some variation in the agreed ratio between CAT points and learning time in different institutions across Europe, but there are also major differences in the provision made for the learning time, especially in terms of media support. In particular, within open and distance learning, there are big differences in the number of student learning hours supported by teaching media and the number allocated for individual work in which students are expected to study by themselves. Table 3.2 documents this. These differences have cost implications. Where course designers can present material in such a way that students need no mediated guidance for most of the time they are studying then, other things being equal, the cost of a teaching package will be much lower than one where such guidance is offered for nearly all the designated hours.

**Table 3.2: Media-supported learning time as proportion of learning time**

Course	SLH (Course) <sup>a</sup>	SLH (Media) <sup>b</sup>	Ratio	Percentage <sup>c</sup>
OUUK: Health and social welfare	220	135	1.6	61%
OUUK: Mathematics	448	306	1.5	68%
NKS: Post secondary adult education	418	88	4.8	21%
NKS: Teacher education	700	103	6.8	15%
APU: Health and social welfare	200	47	4.2	24%
CTU-Rheims: Philosophy	600	315	1.9	53%
IOE Advanced Diploma <sup>d</sup>	600	120 <sup>e</sup>	5.0	20%

Source: own case studies; Notes: a: student learning hour per course; b: student learning hours provided for by study material or contact hours; c: percentage of media input as proportion of student learning hours stipulated for the course as a whole; d: half of an Advanced Diploma (120 CAT); e: contact hours.

### *Print: providing the integrating script*

In calculating the costs of course development we need to decide how to attribute costs to the different media used. We encounter both conceptual and practical difficulties in doing this.

The conceptual difficulties arise from the role of the written language in education. As we saw, the development of text (whether delivered to the learner in print or on screen) has a central role in teaching. It provides the script, which integrates all other media, with the result that it is difficult to attribute the costs of preparing the basic text among the various media used, except in a quite arbitrary way. In our research we found it easier to identify costs for all other media than for print. This was sometimes due to accounting practice, which in some cases simulates an internal market between the different departments of an institution, so that the computer or media departments charge for their services to develop software or make a film while there is seldom a comparable charge for academic staff time in preparing text. Activity costing, which might yield useful data, is seldom yet in place.

The resulting difficulty in attributing costs varies from case to case. In the case of Anglia Polytechnic University (included in the case studies in part II) it has been comparatively simple: a printed document was re-edited for the Internet to include hypertext links as well as computer-aided learning devices and it was possible to derive figures for the cost of adaptation. A full accounting would, however, need to include figures for original writing and for design costs. These figures would also depend on the extent the design was carried over from the print to the screen. Uncertainties like this contribute to the possible margins of error of the cost figures.

In some cases we did not attempt to calculate the cost per student learning hour for print as the costs for staff time could not easily be attributed to different media. The figures for other media are likely to be on the low side as academic staff time may have been attributed to course development generally, and therefore included in the print cost, and possibly underestimated for television and CD-ROM components.

The attribution of learning time to media is also difficult. In practice other media are blended in; a student reading a module may be asked to listen to an audiocassette in order to answer questions arising from the text. Breaking down student time between reading and listening is then inevitably arbitrary.

Despite these difficulties of detail, there are such stark differences in the cost per student learning hour of different media that benchmarks, suggesting the order of costs to be expected, are of very great value in selecting media and planning a course.

#### *CD-ROM: the problem of interactivity*

It is particularly difficult to analyse the costs of CD-ROM. The low replication cost of a disc means that they are often produced without being loaded to capacity. This implies that the mere reference to a disc gives us hardly any useful information about the number of student learning hours to be attributed to it. Also the number of bytes may not provide the information needed to estimate learning time. (A colour photograph recognised in an instant needs more memory than a sizeable amount of print equivalent to many hours of reading.) Accounting for learning time and also accounting for costs requires a more detailed account about what is on the CD and about the processes involved in producing it.

At the simplest level some CD-ROMs contain text together with hyperlinks. Our studies have shown that about six hyperlinks can be incorporated into a text and tested in one hour. Computer-aided learning requires much more expenditure on staff time. A mid-point figure observed for designing computer-aided learning features like computer-marked multiple-choice questions is £10 000 per student learning hour. The design costs for more sophisticated development vary considerably; further costs are incurred, for example, when film clips are included.

We can then estimate the amount of time which the learner might spend on each specific feature. Such estimates are, however, partly normative and driven by the course designers' intention. In other words, we have the data to show how long course-designers expect students to spend on a particular activity but rarely have any information on the actual time spent. Learners generally confirm that interactive features slow the pace of their studies.

Design features in CD-ROM are often promoted as increased quality. In terms of raising effectiveness scores with respect to a set of curriculum objectives it is unlikely that they are always of measurable advantage, even if they enrich the learning experience.

It seems that CD-ROM is a case where educational technology induces some pressure to raise quality, rather than to reduce costs.

#### *Computer-mediated communication: difficulties in attributing learning time*

Computer-mediated communication can be used both as a resource medium - presenting teaching to students and as a communication - allowing asynchronous communication. Whereas videoconferencing tries to emulate seminar teaching or the traditional lecture, the asynchronous character of CMC puts it into a different category. At the same time it shares with videoconferencing the capacity to be used for open-ended teaching rather than to present pre-prepared resource material. As a result, we cannot simply estimate the cost per learning hour for CMC as a resource medium, without taking account of its role as a communication medium. Where CMC is used as a resource medium to deliver instructional content, we can investigate the costs incurred in making material available in digitised form. Generally, however, it is very difficult to estimate the number of student learning hours attributable to a CMC course component.

The Virtual Seminar, run between Germany and America, which used CMC, poses questions of this kind. One might attempt in theory to estimate the cost per student learning hour by looking at word counts, decide on a notional writing and reading time and estimate the average student learning hour from here. However, there is some evidence that students do not pay much attention to the messages of their peers, so that we are left with a measure that is partial as well as arbitrary. In practice there are no reliable research data yet which would allow us to specify the number of student learning hours attributable to one hour of CMC input by a tutor. In this case, therefore, we have not tried to estimate the student learning time in a bottom up way, based on word counts, but have based our estimates top down, using the student learning hour requirements indicated by the course designers.

Where CMC is used to enable communication with students it poses management as well as costing problems. The potential for external interactivity can lead to an explosion of tutor - student communication not anticipated in the budget. Policy guidelines for tutors and students may have to be issued to scale down expectations. It may not be feasible for an institution, or an individual, to meet the costs in money or time for all the interaction made possible. This can be seen as a disappointing effect: technology has facilitated communication to an unprecedented extent only to limit it again for economic reasons. From an economic standpoint communication technologies are a mixed blessing in so far as they facilitate external interactivity. They link teachers and students, with potential educational benefits, but by increasing the amount of tutorial time used in this interactive way they shift the balance of fixed and variable costs back towards variable costs, thereby eroding the economies of scale.

*Video-conferencing: how to account for reduction in opportunity costs*

Many costing decisions turn on departmental or institutional priorities: there may be a case for using open and distance learning if it costs less than conventional education or reaches a new audience. But, in calculating costs, we may need to consider costs that fall outside the institution as well as those within. Videoconferencing provides an example. We found that, in the cases we examined, videoconferencing was likely to cost the teaching institution more than conventional lecturing. But this conclusion omits the question of costs falling on the student. If videoconferencing makes it possible to deliver teaching to a remote student, reducing the time and costs for the student to travel to attend a lecture, then there may be real reductions in the cost to the student even while there are increased costs to the institution. We did not examine the opportunity costs of student time in any detail. They are, however, likely to be significant in the use of open and distance learning for professional and continuing education and for job-related training. The National Technological University, in the United States, for example, provides courses by videoconferencing using a satellite link to feed teaching into its postgraduate students' place of work. Its cost per student tends to be higher than the cost of conventional classroom teaching. But, if we take account of the opportunity costs of students' time - the amount they save by not travelling to a distant location - then its costs are likely to be lower than those of a conventional alternative (cf. Bih jen Fwu *et al.*, 1992)

## **Costing difficulties**

We face a number of difficulties in calculating or estimating the costs of media.

### *Overheads*

The costing of courses is based on the assumption that we can distinguish between institutional overheads and costs that can directly be attributed to a course. In practice this is seldom straightforward.

If we want to calculate the full cost of a course, we need to take account of overheads for such items as administration, accommodation, and the other general costs of running an institution. There are two difficulties in doing so. First, few institutions have embraced activity costing to the extent that they can attribute all overhead costs in a way that makes it possible to calculate these for a single course. It is, therefore, an arbitrary exercise, but may well seem pointless for a manager to define overheads for a particular course. More often, costs, such as the choice of media for a given course, are regarded as sunk costs, i.e. as irrelevant to the decision being taken, so that the analysis is taken no further. The second difficulty is that institutions vary in the way they treat overheads. While each institution's approach may suit its purpose, this makes comparisons between institutions more difficult. We have, in our work, generally accepted the way in which each institution calculates overheads, while recognising that this introduces an element of uncertainty into comparisons between institutions.

We need to take account of the issue of overheads both in comparing the costs of different approaches to open and distance learning and in comparing open and distance learning with conventional education.

If we want to compare the average cost per student in open and distance learning with that of conventional education, we need to calculate the cost per hour of lecturing in the conventional system. This brings in one further complication. The calculation depends both on the treatment of overheads and on the attribution of costs to teaching and research. Where staff are required to undertake both teaching and research we need to decide how much of their time (and therefore the cost of employing them) should be attributed to each. The research commitment in English universities, for example, is currently reported as ranging from 35% to 50%. Thus we may need to consider three sets of figures in order to calculate the cost of staff time: gross payroll figures, which will include superannuation and social security payments as well as basic salary, institutional overheads, and the proportion of time to be allocated for teaching rather than for research. To illustrate the effect of these on costs, some universities charge an overhead rate of 40% over gross payroll costs for consultancy work while the British Committee of Vice-Chancellors and Principals recommends the use of a manpower rate to cover all items which raises payroll costs by 105% (CVCP 1988).



Our treatment of overheads in general is a result of the practicalities of institutional research: there is no other realistic option than to base one's calculation on the data provided. The extent to which overheads are costed with any rigour varies widely between institutions and the basis on which overheads are calculated is in some cases unclear. We therefore need to be cautious in comparing data from different institutions; comparisons within any one institution are likely to be more robust.

### *Annualisation*

In costing we always need to take account of both capital and recurrent expenditure. In the context of distance education considerable up-front capital investment is often required both for staff time in preparing teaching materials and for equipment. Videoconferencing provides one example. Let us assume that it requires altogether a capital investment of £80 000. Generally these costs are to be attributed across the lifetime of the system so that we need to calculate the cost per annum of the capital investment across that period. If we assume a lifetime of five years and a usage rate of 1 300 hours per year, we could simply divide the initial amount of £80 000 by the lifetime of the equipment getting a cost of £16 000 per year.

With 1 300 hours of use we then get a cost per hour of:  
£16 000/1 300 = £12.

In this case we assume that each year we consume a fifth of the value of the system. But this calculation may under-estimate the cost. In each year we could, notionally, have put the money to an alternative use. We can estimate the return that we might have received on it if we had left it on deposit and gained the interest. Each year therefore we forgo not only the depreciated amount but also the interest, which would be gained up to then. This can be accounted for by an annualisation factor, which integrates the number of years and the interest rate. The formula is the following:

### **Equation 3.1:**

$$a(r,n) = \frac{r \times (1+r)^n}{(1+r)^n - 1}$$

The table 3.3 indicates the difference between the depreciated and the annualised capital at different interest rate over five years.

Thus the cost per hour, for 1300 hours use each year, rises from £12 if we ignore annualisation (or treat the interest rate as zero) to £15 at a rate of 7.5%, £16 at 10% and £18 at 15%.

**Table 3.3: Annualisation of capital**

Various interest rates interest at	r = 0.075 7.5%	r = 0.10 10%	r = 0.15 15%
Capital cost of videoconferencing system	80 000	80 000	80 000
Obsolescence time of equipment	5	5	5
Annualisation factor	0.247	0.264	0.298
Depreciated capital	16 000	16 000	16 000
Annualised capital	19 760	21 120	23 840

The significance of these calculations depends on the standpoint of the person doing the analysis. If you are an educational manager, concerned only with the problems of raising capital for a particular development, which is treated as sunk, and of meeting your recurrent costs, then you will be concerned with locating the initial £80 000 and not with a notional cost per annum derived from annualising it over a period of years. Educational managers can seldom in practice choose between using their allocated capital expenditure and investing it in order to get a good return. At a higher level of decision making, however, you may be interested in a full comparison between the costs of a capital-intensive or labour-intensive approach to education so that these calculations become less hypothetical. And if, as an educational planner, you want to compare the long-term effects of conventional and unconventional approaches to education, it is necessary to be sensitive to the cost, over the years, of the capital investment needed for each approach. Where large institutions are investing, say, sums of £500 000 or £1 million in course development, then the annual cost of the capital for this becomes a significant item.

#### *Costs of writing and designing teaching materials*

The difficulties we encountered in determining the cost of writing and designing print material illustrate some of the costing problems. We wanted to find out how much it cost to write materials and how much was then involved in editing and design. In practice, the different ways in which institutions keep their financial records and attribute time illustrates the difficulty in making comparisons between institutions. Table 3.4 illustrates this.

In three cases - at the Open University and CTU Rheims - we could not separate out print and design costs. In the case of the Open University it is argued that figures based on the costs of full-time staff

might overestimate the costs, because of the level of overhead charges attributed to them, and we have taken the costs for external authors instead. In the case of Rheims, the only information available was for hours of staff time, which could not be broken down further.

In other cases the level of detail differed considerably. In some we were given figures representing author-related costs and design costs. In others the only information available was the fee paid to an author with all other costs included in a single figure for print development. The uncertainty inherent in the figures makes it difficult to reach robust conclusions about the comparative costs of writing and of design.

**Table 3.4: Relation of author and design related cost in print development**

Currency: Sterling

	Writing cost per unit	Design cost per unit	Total	Ratio of writing to design cost
OUUK Social sciences	1 200	1 175	2 375	1.0
OUUK Mathematics	1 200	1 199	2 399	1.0
NKS Norsk	1 401	249	1 650	5.6
NKS Barnehaugen	5 785	1 988	7 743	3.0
FVL Engineering	1 520	1 520	3 040	1.0
APU Nursing	667	725	1 392	1.0
CTU Reims Philosophy			2 196	
UOC Law	1 005	2 345	3 350	0.4

Source: own case studies

### Practical difficulties

Alongside the conceptual difficulties and technical difficulties of costing, we had to overcome a number of practical difficulties which arose from the sensitivity of data and the pressures on staff time.

There is a new tension between co-operation and competition in higher education. The rising costs of higher education have induced governments to demand efficiency gains. Higher education institutions are compared with each other with respect to cost per student and, to a lesser extent, cost per graduate. This leads to an understandable caution in releasing sensitive information about costs. At the same time, some academic staff see open and distance learning as a job threat because of the expectation that it may be adopted as a cost-saving measure.

On the other hand there is a public demand for institutions to share experiences, in order to improve overall efficiency, and there are some institutional pressures to do this. Consequently, our experience was mixed, with occasional reluctance to release details about costs in spite of agreed co-operation in

principle. (The problem is by no means a personal one. On a personal level co-operation generally was conducted in an amicable atmosphere. However, there was a considerable degree of inhibition about making data publicly accessible.) These problems could, to some extent, be avoided if one agreed to publish the data without reference to any specific institutions. We rejected this approach, mainly because an understanding of the context is necessary for a full understanding and interpretation of figures. (Anonymity is, in any case, sometimes difficult to achieve: it would be a bit transparent to refer to a large, English-speaking, open university within the European Union.)

Many academic and administrative staff are under pressure. There is little motivation to try to introduce an ignorant outsider into the intricacies of the organisation and its way of costing. Institutions use quite different methods, which defy the template a researcher might want to impose. There is one more difficulty here - a general scepticism about the usefulness of enquiries into cost effectiveness. It may be twofold, reflecting both a concern for job security and a practical conviction that academic staff want to get on with the job of teaching rather than concentrating on funding questions.

## **Conclusion**

These conceptual and practical difficulties influence the way we carried out our work. They need to be borne in mind as a set of limiting factors on the robustness and generalisability of our findings. But, while it is necessary and proper to set them out, they do not prevent our making use of both our cost findings and the methodology we adopted. We look next at the practicalities of applying what we found.