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ABSTRACT

The past 15 years have brought about the large-scale and effective introduction of open learning and distance teaching methods. During the same time period a rapid increase has occurred in the technologies available to educators and trainers. The increase in available technologies has led to the problem of choice. What media should be used for open learning? The importance of the context in which the media will be used is underscored, and a set of factors to consider in selecting media is outlined: (1) access (involving where and when learners will learn); (2) costs (capital, recurrent, production, delivery, fixed, and variable costs); (3) teaching functions of the media (different media represent different kinds of information) and the extent to which they promote active learning; and (4) organizational issues (the nature of the technological structure already in place, the public image of the company or institution, the existing organization of the training department, and the degree to which high-level officials of the adopting system provide their support). (13 references) (GL)

NEC 25TH ANNIVERSARY BOOK

**'Open Learning in Transition: An Agenda for Action'**

Part 3: Methods

# DELIVERY AND NEW TECHNOLOGY

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## 1. Developments in open learning and technology

In the last 15 years, we have seen the large-scale and effective introduction of open learning and distance teaching methods, initially at the higher education level, but now rapidly spreading to vocational training. During the same period, we have seen a rapid increase in the technologies available to educators and trainers. Face-to-face tuition and textbooks have until recently been the main media used for education and training, supplemented by broadcast television and radio. In the last few years, though, to these more 'traditional' media have been added audio-cassettes, video-cassettes, cable TV, satellite TV, pre-programmed computer-based learning, computer-based communications (electronic mail, computer conferencing, access to remote data-bases) and interactive video-discs. We are seeing increasing use of these technologies in open and distance learning, although they can be used to supplement more traditional face-to-face teaching as well.

This increase in available technologies has led to the problem of choice: what media should be used for open learning? A strategy for decision-making in this area is urgently needed.

## 2. Procedures for decision-making

In deciding on appropriate technologies, context is all-important. Obviously, the needs and resources of small companies are different from those of large institutions. A large manufacturing company's training needs, such as that of a car manufacturer, will be different from those of a small college, both in terms of content and delivery.

This means that general statements, like 'video-cassettes are better than satellite TV', are not helpful; it will all depend on the circumstance. Furthermore, we shall see that in educational and cost terms, there is no 'super-medium'; different media have different strengths and weaknesses. This means then that a combination of media is

usually the most appropriate decision, although the balance between media will vary from context to context.

What is needed then is a set of procedures, or a check list of questions that need to be answered, irrespective of the type of institution or level of education or training. There are several different factors to take into account, which cannot be related to one another quantitatively. Thus in the end, an *intuitive* decision has to be made, but based on a careful analysis of the situation.

## 3. Criteria for decision-making

### 3.1 Access.

Access is, in my view, the most important criterion. Basically, where and when will the learner learn? At home; at his or her work-station; at a local centre; or at a central institution? To some extent, this decision will depend on what technology is already available for other purposes. For instance, if every employee to be trained already has access to their own computer terminal and screen for work purposes, then this can be used also for training purposes. If the educational provision though is to be home-based, account must be made of the limited technology available in homes for every potential student.

As indicated in Table 1 (below), *home-based open learning* is currently limited to relatively few technologies: print, terrestrial broadcasting, audio-cassettes, and the telephone. Secondly, the position is rapidly changing for some technologies; for instance, we anticipate that 80% of Open University students will have home video-cassette players by 1990, and probably nearly all by 1996. As teletext decoders become standard facilities on TV receivers, teletext services are likely to be available in most homes by 1996.

Table 1: Home Access to Technology (United Kingdom)

| | 1987 | 1996 |
|---|---|---|
| Print (via mail) | 100% | 100% |
| Terrestrial broadcasts (radio and TV) | 99% | ? |
| Audio-cassettes | 95% | 99% |
| Telephone | 90% | 95% |
| Video-cassettes | 55% | 90% |
| Teletext | 23% | 80% |
| Home computer | 23% | 60% |
| Compact disc | 10% | 50% |
| Satellite TV | 1% | 40% |
| Cable TV | 1% | 35% |
| Video disc player | 1% | 10% |
| Viewdata | 1% | ? |

From various sources, including for 1987: Kirkwood, 1987 (video-cassettes, teletext, viewdata); Grundin, 1985 (audio-cassettes, telephone); Screen Digest, 1987 (video); IBA, 1988 (video, home computers, teletext, satellite, video-disc and teletext); Cable Authority, 1987 (cable) ; for estimates of 1996: Tydeman, 1987 (cable); CIT, 1987 (satellites); the remainder are my own estimates - see text below

However, there will be difficulties in home-based access for several other technologies. Neither satellite TV reception nor home computing is expected to be in more than 60% of homes in Britain by 1996. This could mean that for some home-based target groups (particularly the unemployed and lower-income groups), these technologies will still be inappropriate for home learning. Home computers may exceed the rather conservative 60% of homes I have predicted, but standardisation will remain a problem, since it becomes very expensive to provide learning materials for a range of different machines.

Technologies which reach this intermediate level of penetration

provide difficult choices for open learning institutions, particularly if the technology promises strong pedagogic advantages over other existing media. To what extent is it reasonable to insist that those students without the technology will need to use it? One solution is for the open learning system to help with the costs of hardware on selected courses. The Open University for instance, with the help of a special grant from the Department of Trade and Industry, provides subsidies to students for the purchase of home computing equipment on selected courses. This is a high-cost solution though to ensuring open-ness.

Compact disc is also a difficult technology to estimate accurately. Again the problem is lack of standardisation and rapid technological development. Various forms of compact disc, with different combinations of audio, data and video storage, are all developing at the moment. It is unlikely that even by 1996 there will be a single common version available in all homes. It also seems unlikely that video discs will be a serious proposition for home-based learning in the near future. Unless a common computer/video-disc standard emerges in the next 10 years (which seems unlikely), home-based computer controlled video discs for open learning is just not a practical proposition, especially given the very high production costs.

Cable TV is an interesting case of where a technology may have high penetration in certain areas, particularly in conurbations, and low penetration in others, particularly rural areas. Thus cable may be valuable for localised open learning provision, but not on a national scale, because even the most optimistic of estimates predict no more than 50% of homes being connected in the U.K.

Two areas are subject to great uncertainty regarding suitability for open learning. The first, surprisingly, is broadcasting. A great deal will depend on government policy regarding regulation and competition. While technically broadcasting may still be available in all homes, it

may not be made available to education, if the policy is strictly one of competition and commercialism. Similarly, France has shown with Minitel that a strong central policy could ensure rapid access to viewdata (i.e. telephone-based teletext services), and that educational services will appear if viewdata is widely available (Kaye, 1988). Government policy then is critical in influencing the availability of technologies in homes.

It can be seen that even by 1996, only video-cassettes and teletext are certain to be added to those technologies already available in nearly every home.

On the other hand, training located at the *work-bench* or in *local centres* will be less restricted. For instance, at a cost of between UK£400 and £1000, satellite TV and computer-based learning become realistic propositions for individuals at their work-place. Even video-discs become viable for *local centres*, where they can be shared by several users, or in businesses where they are likely to have another function as well (such as marketing holidays in travel agents).

Henri and Lamy (in press) make the interesting point that choice of media reflects the primary, if implicit, *values* of an open learning system. Certain media (and in this sense, face-to-face teaching may be considered a medium) encourage or reflect certain approaches to teaching and learning, while other media represent different approaches. This can be seen clearly in the accessibility of media for students. Those systems which depend more heavily on attendance at local centres, where more expensive technology can be provided, might be considered less open than those which place greater emphasis on home-based learning being available to all students, irrespective of their income or wealth, even if in the latter case the range of media available for teaching is less. Similarly, a learning system which expects every student to provide their own home-based Macintosh might be considered less open than one which encourages

students to come to study centres to use similar equipment provided by the institution.

It can be seen then that access, in particular the intended location of study, and the over-riding value system of the organisation responsible for teaching and training, are crucial factors in media selection for open learning.

3.2 Costs

A cost analysis should be an essential step in any decision to use technology for teaching. It is surprising how few cost analyses - of any kind - have been done in advance of policy decisions regarding media selection for open learning, and unfortunately, when they have been done, they have tended to concentrate on the least significant of costs, namely capital and distribution costs.

We can make some general statements about costs. First, it is important to distinguish between *capital* and *recurrent* expenditure; second, between *production* and *delivery* costs.

Technologies such as television and computing do require high initial capital expenditure - purchase of a main-frame computer or television studio and equipment; terminals or reception equipment. One problem with capital costs is the rapid obsolescence of equipment, particularly in computing: three to five years may be an appropriate replacement time for a lot of equipment.

*Recurrent* costs are those that have to be found each year to run the system. This would include the staff required to run the capital equipment (e.g. TV production staff), the money spent on production or purchase of training materials, and the cost of delivering it. Lastly, the balance between capital and recurrent costs can vary considerably between media, and even within a medium, depending on whether

services are bought in or produced in-house. Buying in television production for instance reduces capital costs but could increase recurrent costs.

Even more important though is the difference between *fixed* and *variable* costs. The cost of a television production may be considered fixed, because it will be the same whether one or 1 000 students view the programme. Face-to-face lecturing costs though are not fixed; they increase in proportion to the number of students- the more students, the more lecturers or tutors required.

Technology-based teaching differs considerably in the fixed costs of production, in roughly the following ratios for the same amount of teaching material (Table 2 below):

Table 2: Fixed production costs (including overheads) for one hour of teaching material

| | |
|---|---|
| Audio-cassette/radio/teleconference/ face-to-face: | 1 unit |
| Televised lecture | 2-5 units |
| Print | 2-10 units |
| 'High-quality' TV programme | 20-50 units |
| Pre-programmed computer-based learning | 20-50 units |
| Computer-controlled video-disc (from scratch) | 50-100 units |

Technologies also differ considerably in their *variable* costs for *delivery*. The variable cost for delivering a broadcast television programme is zero: it costs the same to transmit whether watched by one or one million viewers; video-cassettes on the other hand vary according to the number of delivery points. The cut-off point for Open University television distribution is 350 students per course: above that number it is

cheaper to send the students a video-cassette, provided it is returned at the end of a course and re-issued. With audio distribution the cut-off point is approximately 1 000 students: above that number, radio is cheaper; below that number, it is cheaper to send students audio-cassettes (which they keep). These cut-off points between broadcast and cassette distribution are specific to the Open University situation, since they relate to the costs charged by the BBC for national transmission and the cost of delivery to individual students' homes. However, they illustrate nicely the difference between fixed and variable costs of distribution.

A number of general points can be made about the balance of costs for technology-based teaching:

1. The cost of putting equipment into local centres or work-stations can far exceed central capital costs (e.g. purchase of a production facility) in certain circumstances (e.g. for organisations with multiple training points).

2. The major cost of teaching through technology is in production and hence is recurrent, rather than capital. For instance, the yearly recurrent cost often exceeds the total start-up capital cost. In general, the recurrent costs of producing good quality audio-visual or computer-based learning materials tend to be underestimated. For instance, at the Open University, the production costs of television exceed the distribution costs by a factor of 9:1. Governments tend to make the mistake of encouraging educational distribution systems but not production systems; there is no point though in having a distribution system if there is nothing to run through it.

3. Technologies vary considerably in their fixed costs. Audio is low-cost; high quality television and computer-based learning are high cost. It is worth pointing out that audio-cassette production and distribution are both very cheap. Delivery costs of one hour of audio

material is less than 50 pence per student, including copying, the cost of the cassette, and postage. Variable costs for face-to-face tuition are very high, although the fixed costs are generally low.

4. The cost advantage of using technology for open learning will depend essentially on the number of students on a course, but also to some extent on the cost of alternative methods to a company. High-cost technology such as high quality television or computer-assisted learning can only be justified for large numbers of students, or where the alternative training costs are exceedingly high. For instance, if a plant has to be shut down for training, it may still be worth having high unit costs for training through technology, if the plant can be kept running.

5. Since production is the main cost, and fixed for any course, fixed costs usually far exceed variable costs. This means that the economies of scale apply: the more students, the more cost-effective media become. To determine whether or not to move to open or distance learning, it is necessary to know the unit cost of teaching by conventional methods. The actual number of students where teaching through technology becomes more economical will depend on the unit costs of conventional teaching.

It is unfortunate that so much emphasis is given to 'delivery' in political discussions of open learning; delivery is far less important than student *access* to technology, and delivery costs are far less than production costs.

3.3 Teaching functions

Media differ in the extent to which they can *represent* different kinds of information. Some media are better than others for certain kinds of representation of particular significance to teaching.

Abstract knowledge is handled primarily through language. While all media can handle language, either in written or spoken form, media vary in their ability to handle concrete knowledge. A lecturer may be able to demonstrate an experiment, and both audio and print can report or describe events. None but television though can fully represent events that cannot be brought into the classroom or laboratory, and only television can provide full symbolic representation of events or movement. Television in particular is very rich symbolically, able to handle all forms of representation of knowledge, except direct experience.

This has several consequences for teaching. Television in particular, and to some extent print and computers, can provide concrete examples. Thus television can demonstrate processes or procedures, 'model' or construct concrete examples of abstract ideas, demonstrate interpersonal communication, dramatise or reconstruct events through documentary-style production. These representational possibilities are particularly important for non-academic learners, who often require concrete examples or demonstration rather than abstract theory.

However, this form of television is much more expensive to produce than the use of television for relaying lectures, since lectures fail to exploit the unique presentational characteristics of television; indeed, audio plus printed notes is equal symbolically to a televised lecture and is more likely to be effective, because they are permanent rather than ephemeral.

Research (e.g. Salomon, 1979) has also indicated that media differ in the extent to which they can help develop different *skills*. Part of this relates to the control characteristics of media and part to the representational features. For instance, computers are excellent for presenting and testing rule-based procedures, or areas of abstract knowledge where there are clearly correct answers. Television on the

other hand, because of its richness of symbolic representation, and hence the need for interpretation, is better at handling ambiguous situations, where a variety of possible learner responses is equally acceptable. This is particularly valuable for professional up-dating and training, where students already have a good knowledge base, but need to adapt to changing situations. Also, television is valuable for mechanical or procedural skills training, where it is important to see relationship between parts, for sequencing of activities, for developing inter-personal skills, and for changing attitudes, through the use of dramatisation or documentaries (see Bates, 1988, for a more detailed analysis of the role of television in distance education).

Another important criterion influencing choice of media is the *control* over the medium available to the learner. For instance, broadcasting (terrestrial, cable or satellite) is an ephemeral medium. The value of cassettes or discs lies not just in their ability to allow students to view or listen to audio-visual material at more convenient times. The ability to replay and search enables learning from television and audio to be much more effective. Indeed, the cassette is to the broadcast what the book is to the lecture.

*Interactivity* - the ability for the learner to respond in some way to the teaching material, and obtain comment or feedback on the response - considerably increases learning effectiveness. This is at its strongest in computer-based learning, where learners can be tested, corrected, or given remedial activities by the computer. The attraction of computer-controlled video-discs is that they combine the strong interactivity of computers with the powerful representational qualities of television. However, this is an extremely expensive medium. Audio and video-cassettes can be designed to increase learner interaction, and do allow for more open-ended and interpretative responses than computer-controlled learning.

These differences between media indicate the importance of not only

looking at costs and access, but also at the teaching objectives, when selecting technologies.

3.5 Organisational issues

The extent to which new technology can be introduced to open learning will depend a great deal on the existing values and structures within an educational or training organisation.

Perhaps the most important organisational factor is the technological structure already in place for other purposes: internal communication, transfer of funds, public relations. Thus if an organisation with multiple outlets already has a computer network, and technical staff to develop and maintain that network, the introduction of computer-based learning or com- puter conferencing becomes that much easier and more realistic. Training then becomes a marginal cost on an already established system.

Secondly, there is the public image of a company or an institution. We have seen that audio-cassettes combined with print materials can be a very low-cost but highly effective open learning medium. But the training manager is not going to get noticed by his board so much for introducing audio-vision as he might for bringing in computer-controlled video-discs: they are much more sexy, and it may be easier for him to 'sell' video-discs to the board, at much higher costs, than the worthy but dull audio-cassette and print. Furthermore, the staff to be trained may feel that their company is being left behind by competitors who have 'high-tech' training provision.

The third factor is the existing organisation of the training department. If training has traditionally been based on face-to-face instruction, often located in pleasant surroundings, and with a generous hospitality budget, it is going to be difficult to persuade the training department itself on the value of open learning or distance training

methods. It will mean transferring, for instance, part of the training budget away from teaching staff into operational departments, such as computing or audio-visual production. Unless this is done, though, it will be hard to justify the use of technology on cost grounds. There will also be a major requirement to train the trainers in the selection and use of technology.

Lastly, innovation in this area depends essentially on 'champions for change' at a high level: a Chairman, Vice-Principal or Board member who is willing to fight for the introduction of new technology and/or new teaching methods. The reverse is also true: inappropriate investment or choice of media often results from ill-informed champions of a particular technology. Board Chairman usually do not have the time to master the knowledge required to make a sensible choice of media for education or training. The role of external consultants then becomes important; unfortunately, far too many consultants are not indepen- dent, but wedded to a particular technology.

**4. Conclusions**

We have seen then that there are several factors to be taken into consideration when deciding on the potential use of technology for open learning: access, and where learners are to study; costs, particularly production costs, related to numbers of students or trainees; teaching requirements, in terms of skills and the kind of education required; the control characteristics of the media, and the extent to which they encourage active learning; and the organisational framework in which technology will be introduced for open learning purposes.

It should be clear by now that open learning will in most circumstances require a mix of media. Some of the more powerful teaching media, like computer-controlled video-discs, are extremely expensive; some of the low-cost technologies, such as televised lectures,

suffer from a lack of learning effectiveness. No single medium can tackle the range of learning requirements and teaching approaches needed in the field of open learning. On the other hand, there has to be some restriction on the range of media that can be used, if only on cost grounds. It is important then to concentrate on a limited range of two or three 'core' media, perhaps supported by one or two other support media.

Far too often, high cost technology is used without sufficient analysis of its likely cost-effectiveness. Government funding policies, based on encouraging new technology, often result in inappropriate technologies being used that actually distort the open-ness and effectiveness of open learning. While then technology can bring many benefits to open learning, in most cases it is not a cheap option, and needs to be used with care and skill. For these reasons, tried and tested media such as print still have an important role to play in open learning.

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