Journal of Distance Education/
Revue de l'enseignement à distance
Fall/Automne, 1986
Vol. 1, No. 1, Pp. 41-57

Computer Assisted Learning or Communications: Which Way for Information Technology in Distance Education?

Tony Bates

Abstract

Two uses of computers for teaching in distance education are compared and contrasted: systems based on structured, pre-programmed learning materials (i.e., computer assisted learning, or CAL), where the learner communicates as if with the computer; and systems based on the communications functions of computers (i.e., computer-mediated communications systems), using electronic mail, conferencing and data-bases to facilitate communication between teachers and students.

It is argued that the two systems represent quite different educational philosophies, and for distance teaching at a higher educational level, the communications mode offers a more appropriate, humanistic, and pragmatic route for future development.

Résumé

Deux manières différentes d'utiliser l'ordinateur pour l'enseignement à distance sont comparées et contrastées: d'une part, les systèmes fondés sur du matériel d'enseignement structuré et pré-programmé (c.-à-d. enseignement assisté par ordinateur ou EAO), ol'étudiant communique avec l'ordinateur, et d'autre part, les systèmes fondés sur les fonctions communicatives des ordinateurs (c.-à-d. des systèmes de communication opérés par ordinateur), employant le courrier et les conférences électroniques ainsi que les logiciels de gestion de fichiers comme moyens de faciliter la communication entre enseignants et étudiants. Nous soutenons que ces deux systèmes sont représentatifs de philosophies d'enseignement fort différentes et qu'en ce qui concerne l'enseignement à distance au niveau supérieur, les modes de communication opérés par ordinateur offrent plus d'opportunités pour l'avenir, aussi bien du point de vue humaniste que pragmatique.

Black Boxes or Networks?

In this paper I shall be arguing that computers can be used in distance education in two quite distinct ways, and that underlying these two approaches are fundamental differences in educational philosophy.

One approach is to consider the computer as a black box which by and large replaces the traditional face-to-face teacher and, more relevantly to distance learning, the printed course materials. From the learner's point of view, it is the box, the computer, which teaches. Students now can learn primarily through a home-based computer. Many believe that reductions in hardware costs, more advanced computer assisted learning (CAL) software based on new languages and developments in artificial intelligence, and the ability to connect at low cost to distant mainframe computers will allow distance educators to design the teaching process so that most of the learning is contained in the box, or rather, in the interaction between the learner and what has been programmed into the box.

There is another scenario, though. This is to consider the computer as merely a channel of communication between learners and teachers. In other words, the computer is part of a network, allowing learners and teachers to communicate directly with one another, on-line but asynchronously and at a distance. The structuring of the teaching is not contained in or restricted by the architecture of the computer, but developed and negotiated between learners and teachers.

While these two approaches can happily co-exist in technological terms (i.e., a system that acts as a black box can at the same time act as a network), they represent completely different educational philosophies, with quite different implications for the organization of distance education.

The aim of this paper is to discuss these two approaches, to ask which direction seems to be more feasible in the relatively short term of the next five to ten years, then to spell out the consequences for the organization of distance education if the network approach is to be adopted. A number of examples from the British Open University (OU) will be used in the paper, for explanatory purposes as well as to provide some support for the positions argued. Before doing this, though, I have to make some assumptions in two key areas: the computer technology most likely to be available to most distance learners over the next ten years; and what constitutes good teaching. The first set of assumptions will set limits on what is possible; the second set of assumptions must be spelled out in order to have criteria for evaluating the differences in approach.

Computer Systems For Distance Learners

There are three different kinds of location where most people undertake distance education: local (study) centres, work, and home.

Local Centres

For over 15 years the OU has used for teaching purposes "dumb" computer terminals in study centres, linked by telephone line to mainframe computers. More recently, the Dutch Open University has placed stand-alone microcomputers (micros) in its 18 regional study centres for study purposes.

It is certainly possible to create sophisticated teaching materials to run on powerful machines at study centres. However, there are major disadvantages in doing this. First of all, this can be only a back-up or ancillary provision to other forms of distance teaching if learning is to be available to as many people as possible. Friedman (1984) has argued that for computer-intensive educational environments on conventional engineering campuses, one high-level work station is required for every two students. This clearly is an impractical arrangement for local centres. There would not be enough machines for all students to do all their learning in this way.

In any case, 25% of OU students never go to a study centre, for various reasons. Studies on students accessing machines at study centres (e.g., Jones & O'Shea, 1982) have found problems: booking difficulties, waiting to use the terminal, machine breakdown, inefficient use of students' time, and so forth. The provision of more stand-alone micros can remove some of the problems, but adds others. OU study centres, for instance, are usually shared with other institutions. If stand-alone micros are to be readily available to OU students at times when they can use them, security becomes a major problem. For most distance education students, access at home is essential if computers are to provide a major part of the teaching.

Work

The workplace is perhaps the most promising area of development for information technology in distance education. Companies can standardize internally on one system, are increasingly likely to have information technology systems already in use for business reasons, and may be willing to invest in information technology for work-based training purposes, where benefits over traditional "off-work" training provision can be easily identified. Consequently, in work situations anything or nothing is possible for distance learners. Companies may be willing and able to provide on-line facilities to a mainframe computer, or stand-alone inter-active video work stations, or access to videotext systems. On the other hand, the company may be able to provide nothing in the way of local work stations for education or training.

This paper therefore is not directed at distance learning through either local centres or the work-place. Instead, it concentrates on what can best be provided to home-based learners.

The Home

What computer facilities can we expect students to have in the home over the next 10 to 15 years? The OU is currently working out a policy regarding home computer provision. For five years starting from 1988 courses are expected to standardize around one common machine specification, to enable students to move from course to course without changing machines. Micro-computer manufacturing companies have been invited to tender for an "OU machine" with the following requirements:

HARDWARE

- 16-bit data address processor
- 512K RAM
- Black and white monitor

- MS/DOS operating system
- Printer
- Communications modem and software
- Disk storage (512K)
- Keyboard (standard QWERTY + IBM PC/AT layout and mapping)
- Price: below C$1000.

SOFTWARE

- MS/DOS[1]
- UCSD Pascal
- Lotus 1-2-3
- GEM
- PC Automator
- Sidekick
- Wordstar (or other word processing facility)

As well as greater computing power and more sophisticated software, other features which may be added to an OU home machine specification over the next ten years are:

- Mouse
- Enhanced colour graphics facilities
- Colour monitor
- Icon features
- A facility to synchronize natural voice with data, either via audio tape or compact disc

While there is general agreement within the OU that standardization on a single system is essential if course development costs are to be kept in control, there is a good deal of controversy about the choice of system. Many of us feel that for teaching purposes, the Apple Macintosh is far superior to an IBM PC (or its "look-alike").[2] Two factors influenced the decision to standardize on MS/DOS. First, students are more likely in their work situation to come across MS/DOS-based systems than Macintoshes. Second, the cost of the hardware must be kept to below £500 if at all possible.

For home work stations, cost is the key factor. We have found in the U.K. that most students on a course are unwilling to spend more than £500 on equipment, in addition to their fees and other costs. There are several ways in which home work stations might be provided. In the first case, students make use of their existing micros (about a third of OU students already have their own micros) or buy very cheap micros if they do not already have one. However, cheap home micros are inadequate for running high quality, sophisticated CAL courseware. Furthermore, there is great variation among students with regard to the type of micro they already own. This would require CAL courseware to be

designed in a variety of versions in order to run on several types of machines. Experience has shown though that conversion of software is extremely time-consuming and adds greatly to the costs of course design.

An alternative would be to use students' existing (low-cost) machines as dumb terminals to a mainframe computer, via the telephone system. However, this requires nearly all work to be done on-line to the mainframe. Working on-line means tying up the home telephone for long periods of time, as well as being prohibitively expensive in terms of telephone charges. It should also be noted that the Open University Students' Association is taking a firm line on this issue, arguing that the University should cover all costs in terms of student hardware, software, and line charges for OU courses.

On the other hand, if the University bears the cost of providing students with a more powerful work station, this could add substantially to the cost of presenting courses. The OU is considering several ways of financing home work stations (including loans and leasing), but to be viable, they all assume a limit of around £500 per work station.

Nevertheless, despite these difficulties, it is now possible to provide home-based courses using local processing via a relatively powerful micro, but also linked through the public telephone system to a mainframe computer.

What Constitutes Good Teaching?

The discussion of potential home computing facilities for distance learners is controversial enough, but it may well come to seem simple compared with the discussion of what constitutes good teaching. However, unless we are clear about what we mean by good teaching, it will be impossible to justify the way we choose to employ computers in distance education.

We are unlikely to get universal agreement on this issue. Teaching involves values as well as techniques. I can therefore state only my own point of view, based on my own values. Secondly, even when we are clear about what we want to achieve as teachers, we do not necessarily know the best way to go about it. Teaching is still as much an art as a science. Therefore, some of my conclusions about what can best be done through computers will inevitably be subjective and open to challenge. However, I am more concerned in this paper to start a debate about the most productive roles for computers in distance education than to conclude the argument, even though it will be clear which roles I favour.

I would like to begin by asking a broad question about what kind of learning our society is likely to need over the next 10-15 years. We are in a period of rapid technological and social change, brought about particularly by developments in information technology. The knowledge base then, on which learning depends, is rapidly changing. Gone is the day when one trained for life at an early age, either as a doctor or apprentice. Much more emphasis needs to be given to generalizable skills ("process" rather than "concept"), and in particular to learner autonomy, that is, getting learners to accept personal responsibility for self-development. The emphasis increasingly in professional and vocational education is on job-specific training that is continuous, rather than once-off, initial training.

Changes in technology also mean that teachers should not have to become highly expert in using specific technologies for teaching (since that technology itself is likely to change rapidly); rather, they should be able to easily create or modify materials for themselves, to intervene and change materials as necessary, and to incorporate new ideas and knowledge as it becomes available. Learners and teachers should be able to concentrate on the learning tasks without concern about how to use the technology which carries the teaching. For this to happen, the teaching technology must be "transparent" to both teacher and learner.

A teaching system for this kind of climate must be very flexible and adaptable, so that new knowledge can be quickly incorporated, easily modified and mediated by teachers. It must easily adapt to individual learner needs, and develop generalizable skills rather than demanding that students learn large quantities of specific information.

What, then, are the features of teaching that lead to the development of flexible learning? The first stage is to *identify the needs* of both individual learners and society as a whole. With adults particularly, this may require extensive negotiation between teacher and student about what is likely to be relevant or useful to the individual learner. This negotiation may need to continue throughout the course of study, as knowlege grows and needs change.

The second stage is primarily concerned with the *selection and presentation of information* The teacher must choose, present, store, and make accessible to learners a wide range of information in a means appropriate to the knowledge to be conveyed. This may mean presenting information using a wide range of symbolic representation: words, pictures, movement, sound, colours, etc., depending on the requirement of the subject matter. However, the information also needs to be *structured and organized* in such a way that it represents adequately the internal logic of the subject matter and meets the needs of individual learners. Material may need to be presented in a specific order or sequence, or it may be necessary to model, simulate or present complex phenomena in a variety of ways.

The third stage is to provide students with *help in learning*. Students must be provided with suitable activities to assist their learning, and given opportunities for practice and revision, to master what is to be learned. Above all, students require opportunities to apply what they have learned to new situations, to use their knowledge to analyze real world contexts and suggest alternative and appropriate ways of using the information they have acquired, of testing their knowledge in real-world situations. It is not sufficient, though, merely to provide learning activities; students must have *feedback* on their performance, *diagnosis* of their learning difficulties, and appropriate *remedial actions* need to be suggested. Means must also be found to motivate students when they face fatigue or difficulties in their study.

Perhaps the most difficult and challenging task in higher education is to help learners to generate new knowledge themselves, to provide new insights and become independent learners. For this to happen, *teachers must adjust*, not

only to a changing knowledge base, but also to changing needs in learners, as the learners' knowledge base and ability to determine their own learning requirements change. Lastly, in many cases there is the need to provide *formal assessment* of competence, in the form of a degree or certificate.

As well as the process of teaching, one also has to make assumptions about the nature of learning. Humans are biologically highly adaptable animals, designed to learn from their environment. So the teacher's role is not merely to teach, in the sense of providing information, but to create an environment which encourages appropriate forms of learning. Teachers thus should be managers of appropriate learning environments, rather than merely sources of information and assessment.

Humans are also social animals. People are generally happier studying when they can share their difficulties and successes with other people in similar situations. Contact with other students can be less threatening and more supportive than even a close relationship with a teacher.

Against this background and with these criteria considered, the next section will compare and contrast two different ways of using computers in distance education.

Computer Assisted Learning

I am assuming that most readers are familiar with the main features of computer assisted learning (CAL). Jones (1984) states that the two most common types of CAL used at the OU are *tutorial* CAL and *simulations*.

Tutorial CAL attempts to simulate a dialogue between student and tutor, but with the computer in the role of tutor. The computer carries out two separate but related activities: It provides information; and it tests students. It may also route students to appropriate information based on the responses given by the student. This model of teaching can be simplified to a repetition of the following cycle: show-test-diagnose-show. The student in such a case may respond to the computer's questions in a number of ways. Multiple-choice responses, where a student chooses one from a number of given answers, is a very common technique. A similar technique is the use of menus, allowing students to select their route through the learning material. Multiple-choice responses or menus usually involve no more than choosing a single key for a response. More sophisticated response modes involve keying in whole sentences, where the computer searches for key words, often making allowances for misspelling or a variety of possible correct responses. The most sophisticated type of response is through touch-screens, where students can not only touch correct answers depending on where on the screen they are located, but may even be able to manipulate objects or symbols on the screen, moving them from one part to another. Perhaps the best example of this is the Plato system. Another way of maniuplating objects on a screen is through the use of a "mouse," which can move a cursor to any point on the screen, and give commands at that point, using the screen as a coded thin-mesh grid.

The other major use of CAL in distance education is for *simulations*. Jones

(1984) states that:

> Simulations usually present students with a number of parameters or variables (e.g., population size or temperature) for which they have been set, the program is run and the output obtained, usually in the form of data, either numbers per se or as a plot of some kind. Having interpreted this output, students will often re-run the program, after modifying the values for one or more of the variables. (p. 81)

She also makes the point that simulations should have some definite goal. This goal may not be explicit in the program itself, but may be set by a "real" tutor or even the student.

Criticisms of CAL

Computer-assisted learning has been around for some time now, and has come in for a great deal of criticism. For instance, a report by the OECD's Centre for Research and Innovation in Paris (CERI) (1983) states that:

> ...all the experts and users unanimously deplore the mediocrity and unsuitability of the courseware currently available and the high cost of good quality courseware. (p. 11)

A number of reasons are given by CERI. They complain about poor computer graphics, no colour or voice input, the difficulty of transferring courseware between different types of machine, and the impact of market demands, which require the software to run on the most common, and hence the smallest and least expensive of home micros. Such courseware is also criticized for promoting poor learning techniques. There is heavy emphasis on drill and practice, passive page-turning, and the use of limited responses (i.e., single keys or individual keywords).

Of course, high-quality CAL coursewere is available, but it is usually very expensive. This is because a multi-disciplinary approach is required for the development of good software, making use of the skills of computer programmers, subject experts, and instructional designers. Preparation of such material is best done on a powerful mainframe computer, and often requires a powerful micro to run on. There also appear to be few high-powered professional organizations with the resources to produce large quantities of high-quality materials, with the confidence of long-term funding, which would allow experience to accumulate. There is nothing, for instance, in the educational computer courseware field to compare with the educational broadcasting institutions in Britain.

Because of the high cost or poor quality, CAL tends to be a marginal activity in most distance learning systems that use it. Nevertheless, it would be an exaggeration to state that CAL is inappropriate for distance education.

Benefits of CAL

CAL is good, at relatively *low* cost, for a number of teaching functions. It can present and store information requiring low levels of symbolic representation (e.g., words, numbers, and simple line diagrams). It is useful for manipulating quantifiable variables, as in simulations, where the rules or relationships

governing the interaction of variables are well known and can be modelled. It is also useful for providing students with restricted activities, allowing them to test their knowledge and identify areas where further work is required; and for this purpose, it does allow students to work at their own pace and obtain feedback.

High-cost CAL is good for presenting and storing information requiring medium levels of symbolic representation (colour, simple animation), where the subject matter lends itself to structuring in the way the computer can handle, and where this is appropriate to learners' needs. It functions well for diagnosing a limited range of student learning difficulties and suggesting alternative routes, for simulating complex multi-variate situations, and for a limited range of problem-solving, again where the rules are known and can be defined.

CAL and Tutors

While tutors can do many of the above beneficial functions of CAL, these functions are by and large rather tedious and time-consuming, and are probably best done through a computer, if the resources are available and the economics justify the activity.

However, there are many other functions carried out by tutors which currently are proving very difficult to emulate throuch CAL at a reasonable cost. While a large computer data-base, such as ECCTIS at the OU, can provide information on every course available for adults in Britain, only a tutor can negotiate with an individual learner or modify a course of teaching appropriate to the learner's needs. At the moment, only a "live" tutor can adjust to changes in the learner as knowledge develops or can assist learners to develop new knowledge. CAL provides a very restricted learning environment; a "live" teacher is needed to create a rich learning environment, and CAL of course does little to encourage the social aspects of learning.

Is Artificial Intelligence the Answer?

At this point, I want to give an example from our experience at the OU to illustrate some of the limitations of CAL. A Science course team wanted to use a computer-controlled video-disc at summer school, originally to teach students the skills of experimental design. The micro and video-disc would between them form a huge data-store of scientific information, equipment, experimental results, and different research designs. The idea was that students would explore this data-base, come up with hypotheses, design experiments to test these hypotheses, see the consequences of their experiments, and obtain feedback. Insuperable problems, though, were encountered when it came to designing ways in which students could test their hypotheses. Not only was there a vast range of possible hypotheses that students might generate, there were also many possible combinations of experiment that would test these hypotheses. The most difficult part, though, was to determine how a Science teacher would have guided students in this situation and then find a way of programming which would have accurately emulated this. What we needed to do was design an "expert system" which would have modelled a Science teacher in the context of helping students to design experiments. The course team had neither the time nor the resources to do this, despite the availability of experienced Science teachers and CAL programmers on the team.

This example highlights three major reasons why CAL is so limited at the moment. The first is to do with the size and functions of computers available to distance learning students. To increase the range of functions that can be handled by sophisticated CAL programs, more computing power is needed. This problem may diminish with time, as the power one can buy for the same amount of money increases.

A more difficult problem is that there still is a lack of knowledge of how teachers teach and learners learn. Unless there are accurate and powerful models of teaching and learning applicable to specific situations (e.g., designing experiments), it will be very difficult to emulate these activities.

The third problem is the lack of appropriate programming languages needed to handle the complexity of activities in teaching and learning, and the volume of information from which teachers and learners need to draw, as soon as one moves away from straight comprehension or rote learning.

Developments in artificial intelligence (AI) and new programming languages based on the findings from research on AI *may* remove the latter two problems. This will depend, though, on a number of factors: home-based students' access to the more powerful hardware needed to run systems based on AI (i.e., expert systems); the range of teaching activities that AI can successfully emulate; and above all, the ease with which course designers and learners can use systems designed around principles of AI.

Even if it does prove possible, after a great deal of investment and research, to design computer courseware that expands the range of functions currently best done by course designers and tutors, the question must be asked: Is it worth it?

Why use computers to emulate (perhaps badly) what teachers can do better? A great deal of money will have to be spent to carry out the research required. Even when such tools are available, it is still likely to cost a great deal of money to create the teaching material because of the complexity of the process. It may need expensive hardware to run on. Lastly, and most seriously, the process of creating teaching material through the use of AI is likely to be so complex that few subject specialists will be able or willing to master it.

The consequence of trying to emulate all teaching activities within a computer is a *black box approach* to course design. In this, the course designer tries to build into the computer the responsibility for selecting, storing, and presenting information, for structuring the teaching material, for providing learning activities, for adapting to changing student needs and for assessing students. While there may be strictly financial benefits in the long run from such an approach (it may reduce the number of tutors needed, for example), it seems to me a very dangerous route to take.

Networks: Computer-Mediated Communications Systems

There is another approach. This is to give much greater importance to teaching as two-way communication between teachers and learners. In this approach computers are one means by which this communication is encouraged and enhanced. Students and teachers are linked together by means of a very large computer network. Figure 1 provides a diagram of such a network. It may be seen from the figure that a student has a home-based micro on which local processing (including word processing) can be done. The student is linked through a telecommunications modem and the public telephone system to a mainframe computer. Through this system a student can communicate, via electronic mail or conferencing, with other students, a range of tutors, or individual members of the course team. The student can also access a range of data-bases.

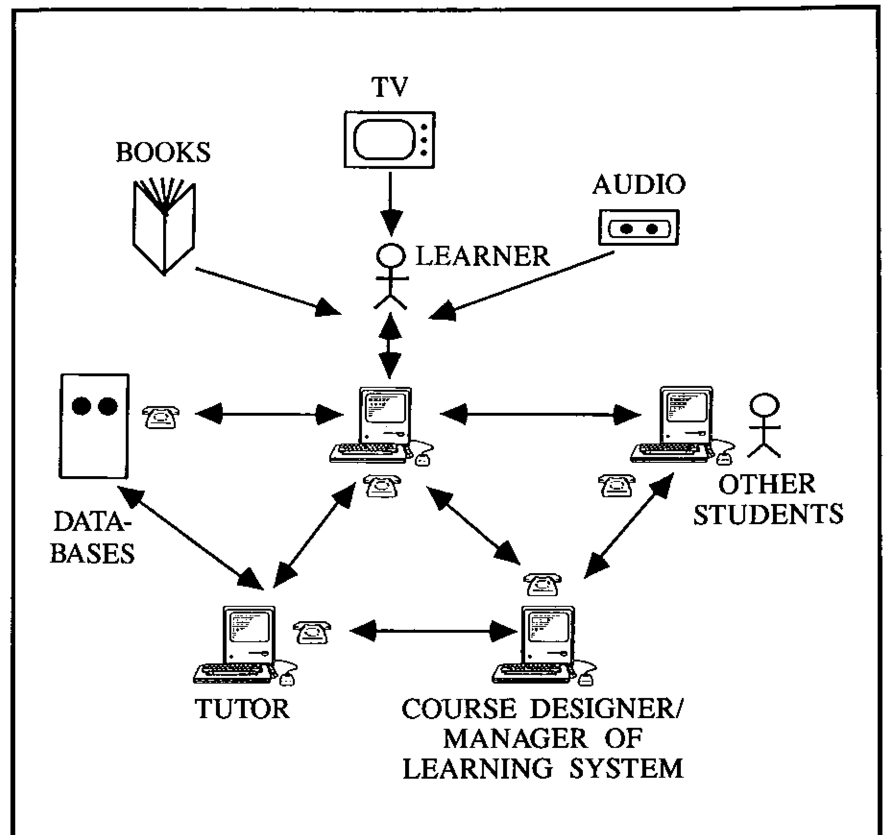

Figure 1 Teaching as Communication

Computer-mediated communications (CMC) systems allow three different kinds of service. The first is electronic mail. This enables students and tutors to communicate directly but asynchronously. Messages are sent as data down the telephone line and stored in an "electronic mailbox" on the mainframe computer, to be accessed by the addressee when convenient. Thus, a student could ask a question of a tutor at the end of an evening study session. The next morning the tutor logs on, collects the question and answers it by sending an electronic message to the student's mailbox number. The student comes home in the evening, logs on and collects her answer. This system can be used for a wide range of functions, including submitting full assignments and registering for courses.

The second function is to set up conferences or bulletin boards. This enables any registered group of users to carry on a conversation or discussion of an issue at a distance. Once a conference is started on a particular topic, any one of the registered participants can add comments to the conference. Another use is for up-dated course information, in the form of bulletin boards, available to all registered students, but which can be added to, amended or deleted only by the course team.

The third function is to allow students to access and manipulate electronic data-bases. Students can call up a data-base located somewhere on a mainframe or minicomputer, search out the information they require, and if permissible transfer that information into their own micro or storage system.

None of this, of course, precludes students from using their home micro as a stand-alone machine as well, for interacting with software delivered physically on diskettes. Indeed, most work will be done locally, prepared in advance of getting on-line, to keep line-costs down.

CMC Systems as Support for Traditional Courses

A project headed by Tony Kay, of the OU's Institute of Educational Technology, aims to introduce CMC systems on a number of courses over the next few years (Kaye, 1985). One such course is TD200, "An Introduction to Information Technology," which will be presented for the first time in 1988. In this course enrolments of 1500 students a year are anticipated. The course is being planned on the assumption that each student and part-time tutor will have a standard "OU" micro system, linked via the public telephone to one of the University's mainframe computer systems. Students and tutors will use British Telecom's public packet switch system (PPSS), which should enable at least 90% of the students to use local call rates for on-line access to the OU mainframe. The average cost at off-peak times (when most students will be on-line) will be less that C$1 per hour. The mainframe computer will be able to handle up to 500 simultaneous connections. It is still undecided which "off-the-shelf" electronic mail/computer conferencing software will be used, the most likely choices being Mail Manager, COSY, or PARTICIPATE.

In this particular course, CMC will be only a part of the teaching system. The course will still consist of printed texts, 16 broadcast television programs, and audio-cassettes. There is a heavy emphasis on practical work, including word processing, spread sheets, accessing data-bases, and using electronic mail and computer conferencing. Students will be expected to do a major project.

CMC will be used in three ways. First, it will be used as a mail service between students and tutors. We are planning for at least one tutor-marked assignment to be submitted electronically. We are considering the use of electronic mail to allow students to work together on their projects in small groups of two or three. Second, it will be used to set up conferences on particular topics to which all students and tutors can contribute. We are planning to incorporate some of the ideas developed at New Jersey Institute of Technology on their system, called EIES. Thus, there will be a "cafe" conference, open to all students, tutors, and course team members; a "student lounge," open only to students; a "staff-room," for teachers only; and individual course topics. Third, we hope to use CMC to enable students to access large data-bases, in particular ECTTIS (on adult course provision in Britain); PRESTEL (a public viewdata system like Telidon); and Times Educational Network, a commercial data-base provided by Times Newspapers for educational uses. It is also likely that there will be a large bibliographical data-base on information technology.

In some ways, TD200, as an introduction to information technology, is an obvious course in which to introduce a CMC system. This course had the essential prerequisites of absolutely requiring a home computer, of being a high-profile course with a lot of political support, of having a course team that understood the technology, and individual members in the course team such as Tony Kaye and Paul Bacsich, who are willing to tackle the many problems that arise from introducing such a system.

However, even in this course CMC is still only a support system to the more traditional methods of delivering distance learning materials. We believe that for certain courses, a CMC system would be highly appropriate as the *main* delivery system.

CMC Systems as the Main Delivery Medium

The kind of courses we have in mind at the OU are advanced-level courses with low student numbers (maximum 100), spread throughout the country, where students are expected to do a good deal of project work and personal research. A CMC system would allow for courses to be tailored to individual students' needs. I set out below a possible scenario.

Tutors would be recruited either from the central academic staff or from other institutions around the country. Each tutor would be responsible for a maximum of 10 students. The tutors would work within an agreed broad content outline, but would negotiate individually with each student, via electronic mail, each student's work program and projects. Students would key-in project outlines and draft project reports for comment and marking by the tutors. Corrected or finalized versions of selected project reports or studies would also be made available to other students for comment.

A good deal of thought needs to be given about the kind of data-base to be provided on such courses. From experience in developing our own in-house viewdata system called "OPTEL" (Bacsich, 1982), we are aware of the high cost of creating a comprehensive electronic data-base, particularly if a great deal of printed material has to be transferred, given the limitations of existing optical document readers. There are several possibilities which could be explored:

- A selection from existing data-bases (e.g., DIALOG) could be made. We are aware of the high cost of direct on-line access, but we may be able to negotiate for the transfer of a limited selection of material on to our own data base; however, we do not foresee the use of commercial data-bases as practical on a large scale.
- Each tutor could be required to spend 10-20 hours contributing to the creation of a data-base in his or her area of specialization; with 10 tutors on a course, this could cover much of the core material for a course.
- Tutors would also provide lists of references and abstracts for the data base; students could access copies of any full paper they required by requesting hard copy stored at the centre. These would be mailed to students, thus keeping down the costs of transferring hard copy to an electronic data-base, much of which might never be used.
- In addition to content and references, tutors would provide a data-base of local resources, e.g., places where students could go locally to access information of a specialized nature, such as museums, university libraries, commercial premises, or evn individual contacts.
- An important source for the data base would be the students' own projects, which would accumulate over the years.
- Finally, it will be important to provide a powerful indexing and search system, so students (and tutors) can find material in the data-base easily and quickly.

A CMC system opens up a whole range of possibilities, including self-registration, fee-payment, and other administrative functions, as well as the more traditional computer education and computer assisted learning. The main obstacle is not so much the technology (although improvements are needed in the mainframe software) nor even the costs, but the major organizational changes that will be necessary to introduce such systems.

Nevertheless, at this stage the following advantages and disadvantages of this technology are apparent.

Advantages of CMC Systems

1. CMC is basically an extension of "real-time" conventional teaching, allowing tutors to respond quickly and sensitively to students' requirements as they arise, but at a distance.
2. CMC can lead to relatively low "front-end" costs: Academic staff will spend less time in preparing materials, and more actually tutoring the course, bringing the central academic staff more directly in contact with their students, and getting courses out more quickly.
3. Perhaps the most important advantage is that CMC systems allow for individualized teaching; up to now, all students have had to study the same material on most distance education courses. This system allows students to negotiate their own project work and areas of study, an important requirement for advanced level, mature students who often have specific study or work requirements.
4. CMC systems allow a distance education institution to respond more quickly to providing new courses; as well as central academic staff, experts from commerce and industry can be recruited as tutors, if the expertise does not exist within the institution.
5. CMC systems improve the speed of communications between tutors and students.
6. CMC systems make course up-dating much simpler, cheaper, and more effective.
7. CMC systems encourage better communication between learners, tutors and course designers, allowing for more open-ended and flexible teaching.
8. Despite some difficulties, CMC systems are relatively easy to use, depending primarily on word processing rather than programming skills.

Disadvantages of CMC Systems

1. There is a danger that such a system will transfer costs to students. They may have to provide the microcomputer hardware and pay line-charges.
2. Major organizational and financial changes are required. The system changes the role of tutors and central academics, and requires new contracts for tutors. Unless the CMC system is to be an additional cost, there has to be transfer of resources away from some areas (such as print production), involving a change in the balance of costs between course production and presentation.
3. While the software for running computer conferencing and electronic mail can be bought "off-the-shelf," the systems we have seen to date are not user-friendly enough; we need a system which is so transparent that neither tutor nor student has to worry about how to use the system. This requires both software development and the production of clear handbooks and operational procedures.
4. CMC is clearly not suitable for all courses. Even a large mainframe could not support very large numbers of students making heavy use of such a system. If used mainly in a support role, it is likely to add substantially to the cost of course presentation. Also, if the system became widespread on distance education courses, it could easily put off many students who do not wish to use or acquire a computer.

The Best of Both Worlds?

As mentioned at the beginning, the black-box and network approaches to computer use are not mutually exclusive. It would be possible to combine elements of both. For instance, a powerful, AI-based expert system could be added to a communications data base and accessed by individual students—but the cost of development would be high. More importantly, the two approaches reflect fundamentally different philosophies of education.

In the black-box approach, as much as possible is put into the machine system (which may integrate several discrete components, e.g., computer, video, telecommunications). The machine system attempts to emulate as many features as possible of good teaching practice, with learners having to move away from the work station as little as possible for their instructional needs. All courseware is accessed through the work station; all activities are controlled and carried out through the terminal. The system provides remedial activities and final assessment.

To develop such a system, a great deal more research and development is necessary. A massive program of research into artificial intelligence and expert systems applied to education and training will be necessary, as will access to powerful machines by both courseware producers and learners. Highly skilled teams of programmers and educational specialists will need to be set up to create teaching materials and software which will emulate good teaching practice. A continuous, on-going system of curriculum development, and adaptation and up-dating of courseware and software also will be needed to take account of changing knowledge.

The main dangers are likely to be lack of flexibility, slowness of change, centralization and standardization of teaching approaches, and the risk of ossifying teaching practice and some areas of knowledge. It would leave the design and presentation of teaching in the hands of a much smaller group of people than currently, with the danger of courseware production becoming isolated from the needs of learners. Underlying such an approach is a real risk of dehumanizing the teaching process.

The emphasis in the network approach is on information technology as a decentralized communication system between teachers and learners. The aim is to use these systems not to replace teachers, but to facilitate their communication with learners (and each other). The work station would be but one component of the teaching system, with other components being books, television and face-to-face contact, with the various components not necessarily physically linked to one another.

Individual teachers would use information technology to help learners access information, to communicate with learners through electronic mail, and to create and amend their own teaching material. Learners would also use the system for communication with their teacher, other subject experts and other learners. What the machine system does not try to do is emulate all the features of "good teaching," such as diagnosis, selection of appropriate remedial work, and management of the learning process. This is left to the teacher, who has personal knowledge of each individual learner's needs, strengths, and weaknesses. Learners are also able to carry out learning activities outside the machine system, where suitable or convenient, e.g., in real situations, and to ask for help from a "live" teacher. The benefits of this networking, modular approach is that it enables teachers and learners to remain in control of the teaching process. It also allows for the rapid creation of large amounts of educational material specifically designed for individual needs. This material though can also be accumulated on a main data base, and accessed and amended by other teachers.

Clearly then, these two approaches do reflect quite different philosophies regarding the use of information technology in education and training. With finite resources for development and research, it is necessary, I believe, for distance education institutions to make a choice about which route to follow.

Reference Notes

[1]DOS is the "disk-operating system" developed by Microsoft Corporation. It is the fundamental software which enables the computer to run application programs such as spreadsheets, word processing, or databases.

[2]A "look-alike" is a microcomputer manufactured by another company, but which uses the same, or most of the same, software.

References

Bacsich, P. (1982). *OPTEL: An Open University Viewdata System.* Milton Keynes: The Open University.

Centre for Educational Research and Innovation. (1983). *Information Technology in Education and Training*. Paris: OECD.

Friedman, E.A. (1984). The wired university. *IEEE Spectrum,* November.

Jones, A. (1984). Computer-assisted Learning. In A.W. Bates (Ed.), *The Role of Technology in Distance Education*, London: Croom Helm.

Jones, A., & O'Shea, T. (1982). Barriers to the use of computer-assisted learning. *British Journal of Educational Technology, 13*(3).

Kaye, A (1985). *Computer Conferencing for Education and Training: Project Description.* Milton Keynes: The Open University.

Acknowledgements

I am indebted to David Kaufman, who first introduced me to computer communications. This paper makes heavy use of the work done at the Open University by my colleagues Tony Kaye and Paul Bacsich on computer communications, and the Open University's Computer-Assisted Learning Research Group on evaluating CAL.

Someone once said of a paper given by Sigmund Freud, "What is true is not new and what is new is not true." What is true in this paper comes from my colleagues; what is new, I am afraid, is my responsibility entirely.

A.W. (TONY) BATES is a Reader in Media Research Methods at the Institute of Educational Technology, The Open University, Walton Hall, Milton Keynes, MK7 6AA, England. He specializes in the uses of video, television, satellite, and computer technologies in distance education.