Has Tele-Learning Come of Age?

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Tele-learning is an increasingly popular idea but it may not be as new as many people think. Some 20 years ago The Open University in the UK, facing financial problems not unlike the problems facing many universities today, began to develop a system which aimed to allow a tutor to communicate with students over the telephone line allowing both to draw on their TV screens whilst viewing the work of the other. The system, called Cyclops, was never used seriously by the Open University. There are many reasons for this, some political, some technological and some financial. It was an idea too far ahead of its time.

In many ways the design goals of Cyclops have now been achieved, not by the Open University but by Microsoft and its satellite companies, in the current set of tele-communication software such as NetMeeting that come free with many PCs. In this paper we look at the current state of such hardware and software and examine the opportunities and opportunities cost of using tele-learning.

Keywords: Tele-learning, British Open University, Distance Learning

1. Introduction

Since the early days of computers, their use as teaching tools has been attempted with varying degrees of success. Acronyms such as CAL (Computer Assisted Learning), CAI (Computer Aided Instruction) etc, have sprung up, demonstrating the efforts that have been made in this direction.

Recently, increasing interest has developed in the possibility of tele-learning, where computers are not only used as tools to aid learning, but also to make it possible to learn from a site which may be physically remote from the human teacher. For our purposes, we define tele-learning as distance learning involving at least an element of real time interaction with other people, mediated by information technology. We would include in this definition arrangements such as video-conferenced tutorials or electronically mediated self-help study groups, as well as study using computer-based courseware where this is carried out at a site remote from the support of a human teacher. However, in the latter case, the courseware would not be the only means of learning: by our definition the student would also have remote access to other students and/or a tutor.

It should come as no surprise to the reader that the development of the hardware, software and courseware needed to make a success of this venture has been much more difficult than pioneers in the area dreamt. Had they known, they might never have started!

The Open University in the UK is the largest university in the country, with over 210,000 students. It is a distance learning institution, catering for mature students who usually undertake their studies part-time. The majority of the students (about 190,000) are in the UK, but there are over 20,000 students studying outside the UK [Open University 1997]. By its very nature the Open University suffers from the large distances separating its tutors from their students, both in the UK and overseas. Tutorials are infrequent and often not well attended. As an Open University student one has to balance the cost, in terms of time and money, of attending a tutorial with the benefits gained and compare this with what can be achieved by staying at home and studying.

In the early 1970s it was expected that most Open University students would have a television and telephone but not necessarily a calculator and almost certainly not a video recorder. Could computer technology be used to connect

tutors with their students in a manner similar to face-to-face tuition? The strategy was for both tutor and student to have a box of electronics (Cyclops) which would enable both to draw on their TV screens and both TV screens to be updated in real time. The communication was to be through the telephone network.

In some ways the proposed system was too far ahead of its time to be achievable using the resources of the cash strapped Open University.

2. Description of Cyclops: Hardware and Software

There were two configurations of Cyclops; one for use and one for the production of 'programs' [Read 1978].

In normal use one had a TV set, connected to a small box called Cyclops which in turn was connected to a keyboard, light pen and a modem. In today's multimedia PC terms the TV acted as a monitor with Cyclops in place of the PC.

Resolution on the screen was 256 × 256 and in black and white only. This restriction stemmed from the addressing capability of the processor and most importantly from the cost of memory.

On a good day, modem data rates over the telephone network were 1200 baud in one direction and 300 in the other. Improvements in this technology have stemmed from better error correction and, most importantly, the replacement of the old 'Strouger' selectors at the telephone exchange with electronic switching gear and other techniques such as compression and improvements to transmission media.

At the heart of the Cyclops Box there was a 6800 processor with 8k memory. Backing store consisted of a standard cassette tape as would later be found in early personal computers.

A light pen was the device used to draw on the screen (as far as we are aware, at that time the mouse was not generally available). From an HCI point of view, for drawing applications the light pen, or stylus type input device, is preferable to the mouse. Unfortunately, the light pen was technically very difficult to make reliable for use as it had to be kept at near right angles to the screen. Modern graphic tablet input devices have picked up where the light pen left off but they are at present too expensive for everyday use.

For those readers who are too young to remember the 1970s, it may be hard to believe just how innovative Cyclops was. We have already noted the very crude graphics with 256 × 256 resolution and only 2 colours. Even simple animations seemed a real achievement.

One of the best features of Cyclops software was something called the '@ language'. It was a shorthand method of specifying where text appeared on the screen and any properties of the text such as boldness etc. The language was compiled into a code that Cyclops could interpret.

An important feature of the @-language was the ability to define macros. Thus a commonly used sequence of bytes would be coded, as for example @1, and whenever this appeared in an input file the interpreter would expand it.

It was argued by some of the team that rather than being a fixed program computer Cyclops should have the ability to receive a program that could then run. It seems to have taken 20 years for others to rediscover the idea and to make it happen. It is now happening in a very big way. With 20-20 hindsight it is very easy to see a preview of HTML and ultimately the Java language itself!

3. Plus ça change, plus c'est la meme chose?

Before moving on to look at the changes that have taken place in distance learning over the twenty years since Cyclops was being developed we think it might be a little sobering to say something of what has not changed.

Firstly, of course, the financial state of Britain's universities is if anything much worse than it then was. The principles of distance learning are almost the same. For an Open University tutor, and despite reorganisations of almost everything, work at the coalface seems to be much the same. Tutors see few students in the flesh at infrequent intervals and most contact between tutor and student is over the phone network using their voices!

The major changes having a bearing on tele-learning that are easily detectable have almost all been in the development of hardware. The only exception is the change to our potential customers who have now become much more aware of the potential benefits of technology and its wide applicability, at least to the entertainment market.

Undoubtedly the cost of hardware has plummeted in real terms.

Computer speed has changed enormously. We estimate that the speed of computation has improved by a factor of a thousand, a 1 MHz 8 bit computer being replaced by a 200 MHz 32 bit computer.

Memory too is in plentiful supply. Again an improvement of a thousand fold would be our best estimate, thirty-two kilobytes being replaced by thirty-two megabytes.

Backing storage again a factor of over a thousand, from 100 KB floppy disks to 100 MB Zip disks to 2GB Jaz disks and no doubt beyond!

Communication speeds have also improved greatly. With the gradual introduction of ISDN, ATM and probably most significantly cable, we should see these speeds increase much further in the near future.

At the time of Cyclops, Motorola was the dominant processor manufacturer and CPM the dominant operating system. Now Motorola, though still a major player in some areas, has given way to Intel. Someone invented Microsoft and Windows rules the world.

Over the last 4 years there has been a rapid convergence in computing. The Internet has ensured that most of the world's computers can, for the first time in the history of computing, communicate and, even better than this, they can run the same Java programs! It is amazing, though it should not surprise us, that a little potential commercial gain can generate more progress than twenty years of hard work!

4. NetMeeting

As an example of one of the products now readily available and changing the way we communicate we will say a little about Microsoft's NetMeeting [Microsoft 1997]. This is a fairly new product. It achieves all that we expected from Cyclops and more. It is a 'real time' Internet phone voice communications client that includes support for international video conferencing.

Features include:

> multiparty calls, application sharing, clipboard sharing, file transfer,
>
> whiteboard, chat and a user location service

Whittaker [1995] offers support for the view that the ability to share 'work objects' is likely to prove very important in remote interpersonal communication. Multiparty calls are an extension of the Internet telephone call to more than two people. Data including video and voice can both be exchanged allowing a commentary, for example, on experimental results.

Application sharing refers to the ability of a number of users to use an application that resides on only one of their machines. So students could demonstrate a program that they had written to their tutor without the tutor needing a copy of the program.

Clipboard sharing enables users to exchange clipboard contents providing transfer of data with immediate feedback to the sender.

File transfers are simply drag and drop procedures enabling a user to send a file to another (or others) by simply dragging it into the meeting.

The whiteboard is a distributed multi-user drawing application not unlike the original Cyclops except that more than two users can draw simultaneously. This ability to mediate two way simultaneous communication is very useful for student- tutor interaction. The tutor, although not present *with* the student, still has a presence *to* the student. Thus corrections to student work can be immediate and both can react to the other's comments.

Chat refers to the ability of users to type to each other as in the 'talk' facility of many UNIX systems. Threaded notes of the conversations can be stored for later reference.

A user location service provides dynamic addresses allowing users whose Internet addresses vary depending upon the session, to be looked up in an address book. This is essential, as some

Internet service providers do not provide their users with a permanent IP address.

In summary this form of computer mediated collaborative working seems particularly useful in education because it combines interaction with a teacher with multimedia facilities offering a variety of methods of explaining and clarifying ideas.

5. Other Developments

Unfortunately the developments in infrastructure, hardware and software have not been matched by comparable development in the methodologies of courseware production. There have been developments but they have not been as rapid.

With the development of the Internet and its authoring tools we now have a better set of multimedia development tools available. Most visual programming languages have multimedia tools integrated.

Much work has also been done on modelling multimedia information systems [Agius 1997], the development of methodologies for remediation [Siemer and Angelides 1996], and for the selection of teaching strategies [Angelides and Tong 1995] to name just a few.

6. Opportunities

Because of its unique position the Open University was a pioneer in the area of using interactive multimedia for teaching support. Recent developments at other UK universities, such as franchising and split sites have meant that they are now trying to reach a geographically dispersed student population. There is also an increasing interest in opening up access for groups of students who for a variety of reasons may find physical attendance at classes difficult. These developments, together with the greatly increased number of students, have provided much of the impetus for the current interest in multimedia teaching.

Possible applications include stand-alone courseware, Internet and CD-ROM information resources and possibilities for remote teaching, both interactive and otherwise.

For example, in the UK at the University of Coventry a 'virtual project room' where project students can share resources, look at what has been done before and receive advice from tutors is currently being set up [King 1998]. This will be of particular use to part-timers and students at franchise colleges who may well be too far away from Coventry to have ready access to the 'real' facilities.

Another development underway at Staffordshire University allows video conferencing between University staff and students in local schools [Durham 1997]. Greek Universities are also preparing to experiment with similar schemes for remote lecturing [Stephaneas 1997].

The two main means of distribution of multimedia material, via CD-ROM and the Internet, should be contrasted. The marginal costs of producing CD-ROMs are very small (less than £1). This has been exploited by the computing press, for example to distribute 'freely' a great deal of useful (and some not so useful) software. The ability to store encyclopaedias on CD-ROM has certainly increased the distribution of knowledge at least in the western world.

On the other hand, once produced, CD-ROMs are static in time and so their contents can easily date.

Distribution via the Internet is certainly more costly than on CD-ROM, at least to the end user. The phone cost of downloading 640MB (the equivalent to 1 CD- ROM) is often rather more than the £ 1 marginal cost of the CD-ROM. It does however have the advantage that use can be traced (at least the down-loader can be identified) and the material can be dynamic and up to date.

Now that the infrastructure is in place (or nearly so) and the technology (in the form of an inexpensive PC, modem etc) is readily available in many homes, the opportunities for the delivery of relevant, high quality material that is constantly kept up to date becomes a reality.

The cost of producing courseware is high and is likely to remain high in the foreseeable future. However, the duplication and distribution costs are much less than with conventional course delivery.

A compromise between the two methods of distribution has been reached by many publishers. For example an increasing number of computer programming books include source code on CD-ROM. An associated web site is also available for corrections, software updates and other news that may be of interest to the readers.

7. Dangers/disadvantages

The opportunities of tele-learning must not make one lose sight of the very real problems that such technology may bring with it. We will highlight a few.

Firstly, a problem that is common to many formal delivery mechanisms is that the learners are often so in awe of the technology that they become too uncritical of it. There is a risk, too, in endowing a machine with the authority of a teacher. Both these factors may contribute to a tendency in learners to accept things because the computer says so. This may mean that badly constructed courseware, which contains errors in the material being delivered, can result in many (possibly hundreds or even thousands) people being given misconceptions that are difficult to unlearn. We once saw a demonstration of some CAL software for mathematics teaching which tested the learner using a multiple-choice method. Unfortunately the author of the package (an experienced primary school teacher) had confused the order of operations in $1 + 2 * 3$ and expected 9 to be chosen as the correct answer. The correct answer 7 was not an available choice!

This true anecdote may be amusing but consider the damage that may be done if more subtle mistakes are made, for example in management training aids. It is easy to see how a mistake in material on, say, employment law or equal opportunities practice could have very major effects if assimilated by learners into their practice.

Where the Internet or CD-ROM is being used as an information source there seems also to be a tendency towards uncritical downloading of material without any attempt at analysis or synthesis. This tendency, rather than improving the student's learning experience, may well stifle it.

An even more dangerous issue is the replacement of a system where human contact is the norm to one in which human contact is only for rare remediation. We do not always appreciate the amount of extra learning that students do whilst watching an expert work in real life. For example, the varying speed with which one mathematics lecturer was able to generate steps in the proof of theorems highlighted for one of the authors the variability in difficulty of the steps. This information is not available from textbooks and it may not be available in technology-mediated instruction unless actual real time interaction with a tutor is included or the importance of such features was appreciated and steps were taken to include it in the courseware.

Some would question whether multimedia courseware will take over teaching to any great extent. Past promises of teaching machines and programmed learning systems which would make independent learning the norm have not yet born despite the effort expended. Teachers are still with us and many would agree with the German proverb 'a teacher is better than two books'.

One of the most important functions of the teacher is to identify mismatches between the learner's knowledge and abilities and the material being presented and to adapt the presentation to overcome difficulties in learning. Whilst considerable effort has been devoted to automating this in intelligent tutoring systems [Seimer and Angelides 1996], the degree of individuation which may be needed arguably makes a human teacher more effective.

Developments in multimedia allowing remote interaction may mean that this teacher contact need not be face-to-face. However, interesting issues seem likely to arise as to how effectively teachers and learners can pick up subtle clues from one another over a remote link and hence whether actual face-to-face interaction is preferable wherever it is possible. Whittaker [1995] discusses in detail the increase in formalisation, reduced interactivity and difficulties in directing attention over a variety of remote links, as compared with face-to-face interaction.

There is an increasing trend for students wishing to study at a university in the UK to go to their nearest one, probably partly as a response to financial pressures. With the increasing competition between such institutions, the levelling

of the 'unit of resource' and the increasing use of technology in learning, it is very likely that the major 'unique selling point' of most universities will be their ability to provide their students with local support. If we go down the route of replacing face-to-face support with electronically mediated support, then the students might as well register with the larger international institutions such as MIT. This possibility should serve as a warning to those in universities that are moving fast towards replacing the expensive (in management's eyes) lecturer by CAL systems. If we do finally manage to perfect a CAL system that needs human mediation only in exceptional circumstances and that intervention is online, then what is the purpose of the University as we know it?

8. Conclusions

The idea of tele-learning is far from new, having been attempted by distance learning institutions such as the UK's Open University some 20 years ago. Workers at the Open University designed and built a system called Cyclops which was to enable two way, remote, real time student tutor communication Their attempts seem to have been thwarted by poor infrastructure, costs and other limitations of hardware at the time.

Although technology has advanced a great deal over the twenty years since Cyclops was first being developed, progress in the application of tele-learning has been very slow. The production of suitable courseware has been erratic and what has been produced was often not widely used.

Now, however, the conditions seem right for tele-learning to flourish. Hardware costs have plummeted whilst its capability has improved by about a thousand fold. The needs of teaching institutions, at least in further and higher education, are more pressing, with the opening up of access and the increase in student numbers. Finally, in the UK, at least the government has begun to think about the benefits of technological help for some of our educational problems.

These conditions lead us to believe that in the field of tele-learning the next twenty years will not be as barren as the last. Let us hope that this turns out to be the case.

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