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ABSTRACT

Microcomputers have revolutionized distance education in virtually every area. Used alone, personal computers provide students with a wide range of utilities, including word processing, graphics packages, and spreadsheets. When linked to a mainframe computer or connected to other personal computers in local area networks, microcomputers can facilitate communications between students and tutors, students and other students, tutors and other tutors, students and a school's administration, and tutors and the administration. Electronic mail even permits communications with other persons and institutions throughout the world. Microcomputers, especially when coupled with the capabilities of word processing software, graphics packages, and course authoring templates, can dramatically speed up and improve the course development and instructional materials production process. Computer-assisted and computer-managed instruction have both proved extremely successful at universities throughout the world, including the British Open University, Miami-Dade Community College (Florida), and North Island College (Canada). Courseware can easily be distributed via computer in the form of computer-assisted learning lessons rather than in printed form. Computer conferencing is another computer-mediated communications system that has proved extremely valuable in distance programs throughout the world. Microcomputers can also be used by distance learners to register for courses, request instructional materials, or complete various administrative forms (such as changes of address). The paper contains a brief foreword, written in German, by Helmut Fritsch. (MN)

FernUniversität
Gesamthochschule

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Greville Rumble

The use of microcomputers in distance teaching systems

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Z I F F - P a p i e r e

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Helmut Fritsch

Anstelle eines Vorwortes:

Kommunikative Validierung von Texten - Argumente gegen den PC

Kollegen hört man immer häufiger stöhnen über die Schwierigkeiten beim Erlernen von neuen für Wissenschaftler auch nützlichen Qualifikationen, wie den Umgang mit dem PC, insbesondere den Textverarbeitungssystemen. Das Gefühl trügt nicht. Einerseits will man ja in seinem Berufsleben nicht von den eigenen Kindern jetzt schon überholt werden, andererseits sind es nicht nur "Modernitäts"-Argumente, die für den Einsatz neuer Technologien sprechen.
Klar, die neuen Medien zerstören massenhaft Arbeitsplätze. Soll wohl auch so sein, daß gesellschaftlich nicht unbedingt sinnvolle Arbeit (wie das zum 3. Mal Schreiben ganzer Texte) dem 'Fortschritt' geopfert wird.
Aber hier tauchen jedenfalls bei uns in einem kleinen Forschungsinstitut - einige bisher zu wenig beachtete Aspekte auf:
Unsere Sekretärin wurde mit dem neuesten Produkt des Hauses - einem mit LA Tex geschriebenen Papier - konfrontiert. Erste Reaktion: sehr schön, in der Tat, das Erscheinungsbild ist perfektioniert (mit der Gefahr, daß auf das Erscheinungsbild zu sehr geachtet wird zu Lasten der Inhalte).
Für die Autoren aber noch wichtiger war die zweite Reaktion: "Jetzt muß ich das extra lesen - wenn ich's selber geschrieben hätte, bräuchte ich's nicht nochmal zu lesen". Und in der anschließenden Diskussion wurde uns klar, wie gefährlich die schnelle Perfektionierung mit PC oder am Großrechner sein kann: Der Autor schreibt selbst, korrigiert, das System setzt um, perfektioniert und der 'output' ist schon da. Der Produktionsprozeß ist beschleunigt, aber eine Komponente fehlt, auf die wir nicht zu verzichten bereit sind.

Der erste Leser:
Gerade wenn es um 'Veröffentlichung' geht, bedarf es häufig des 'ersten Lesers', um Mißverständnisse noch ausräumen, um Passagen verständlicher formulieren, um Relevantes von Irrelevantem besser unterscheiden zu können.
Die Gefahr, daß Unverständliches, fachidiotisches, Irrelevantes - wunderschön, ordentlich, perfektioniert - in Druck geht, diese Gefahr ist ohne eine Sekretärin, die als erste Leserin den Text behandelt, als Kommunikationspartnerin zu verstehen sucht, was sie da schreiben soll, zu groß, um einfach übergangen zu werden. Ich möchte auf meine Erst-Leserin nicht verzichten.

Ist es wirklich schneller, besser, perfekter? Ich zweifle noch lange, denn mir zerrinnt allzuviel Zeit durch die Auseinandersetzung mit den unendlich vielfältigen Möglichkeiten der neuen Technologie. Noch wichtiger aber ist die

Einschränkung des Denkens. Ich zweifle, ob die vorgegebenen Strukturen nicht doch auf das Denken abfärben. Jedenfalls ist es mir schon passiert, daß ich im Hinblick auf die 'Machbarkeit' inhaltliche Erwägungen vernachlässigt habe.

Damit aber sind wir beim theoretischen Problem. Die neuen Technologien - ich rede hier von PC und Tex (diesem perfektionierten Textverarbeitungssystem, das mehr kann, als ich von einem ausgelernten Drucker je erwartet habe) - geben vor, alle Möglichkeiten anzubieten, nur Inhalte haben immer weniger Bezug zur Form. Die Inhalte können die vorgestanzten Formen jedenfalls nicht beeinflussen, eher umgekehrt. Ich möchte vor dem kommenden Zeitalter warnen, wo wissenschaftliche Texte zu Texten verkommen. "Brecht die Macht der Technicians". Laßt wieder selber schreiben!

THE USE OF MICROCOMPUTERS IN DISTANCE TEACHING SYSTEMS

Greville Rumble
The Open University, United Kingdom

In the ten years that have passed since 1975, when the FernUniversity began its work, the computing world has changed. It is not too far fetched to talk *not* about the pre- and post-computing age, but about the pre- and post-microcomputing age. In 1975, however, we were only on the threshold of the new age. Apple Computer Inc. had been established in 1975. Tandy Corporation, set up in 1977, launched its TRS-80 microcomputer. The next year the Apple II microcomputer and VisiCalc spreadsheet introduced to the potential of low-cost, high-powered desktop computers. Other companies - DEX, Xerox, Texas Instruments, Commodore, IBM, Bell and Howell, were entering or about to enter the market. There was a sales' explosion of hardware and a massive increase in available software which is still continuing. Business has been and is being revolutionised. And, if I am right, distance education is being and will be too.

This revolution, I contend, is already affecting virtually every area of distance education: materials development and production; materials distribution; computer assisted learning; communications (student to tutor, student to student, tutor to tutor, student to administration and tutor to administration); and administration.

Before I begin to outline some of these changes and their implications for distance education, I need to say a brief word about the facilities that are needed - for it is the technical revolution of the last few years which has created the opportunities for distance educators.

First of all, and most obviously, personal computers. They can, of course, stand alone and provide access to computer power which enables extensive programing and quite sophisticated applications to be undertaken. With appropriate software, the stand alone personal computer will provide its user with a range of 'utilities': word processing, graphics packages, spreadsheets, etc. It also offers its user a vast array of information gathering and processing capabilities. Information processing needs to be distinguished from data processing. *Data processing* focusses on largely quantitative tasks such as financial and inventory control, and the processing of student records, and is best done on a mainframe computer. *Information processing* enables administrators and evaluators, for example, to undertake tasks that were once performed manually - budgeting, planning, financial modelling, forecasting, preparing management information in graphical form - in a fraction of the time and with a much greater degrees of accuracy than was previously possible.

Personal computers can also be linked to mainframe computers and to other personal computers. Local Area Networks (LANs) can link a group of personal computers to shared peripherals. Individual or groups of personal computers can be linked to a mainframe computer. This can give the personal computer user access to an enormous mass of information, as well as enabling him or her to make use of some of the facilities available on mainframes - such as electronic mail and conferencing systems. One further possibility involves connecting a personal computer in one's home to a mainframe at the office, thus allowing individuals to work at home but communicate electronically with the office through the public telephone network.

Finally, through electronic mail systems, one can communicate with people around the world. For example, the Open University and Deakin University in Victoria, Australia, have agreed to offer members of staff reciprocal user rights on

their mainframe computers. Some Deakin University satff have user codes on the Open University's DEC-20, allowing them to log-in to the computer, creat and edit documents, and send messages to the Open University staff. Open University staff can log into the Deakin mainframe, leaving messages for Deakin staff. The message sender always incurs the cost of logging into the remote computer - thus avoiding the need for people there to log into a remote computer to check whether there is any mail waiting for them. Sending a message is not prohibitively expensive because Australia and Britain along with other countries operate a 'public packet-switched network' which allows a user who has a microcomputer to make a telephone call to a reasonably local number, which then links through the network to the computer he or she wishes to call. Deakin users wishing to communicate with the Open University use the Australian PPS AUSTPAC to log on to the Open University's computer, while Open University staff use the British PSS (Castro, Stirzaker, Northcott and Bacsich, 1986).

Some networks already link large numbers of computers thus getting round the need to log into a 'remote' computer. Messages put into such systems are automatically forwarded to the addressee's local computer. In the United States ARPANET links many hundreds of computers, allowing a user on any computer linked to ARPANET to send a message to a user on any other. In Britain most university computers are linked into a network called JANET (Joint Academic Network); in Australia a similar function is performed by ACSNET; there is a German research network DFN (Das Deutsche Forschungsnetz). The European Academic Research Network (EARN) links mainly non-university research institutions and national networks (such as JANET and DFN) in 15 European countries. Unfortunately particular networks are not always linked together.

In the absence of a 'network of networks', the only option is to use a commercially available system such as ITT-Dialcom, which is an electronic mail software designed to run on a number of large computers round the world. Thus another Deakin - Open University link which does away with the need to log into a 'remote' computer is based on the commercially available electronic mail network run by British Telecom under the name of 'Telecom Gold' in the United Kingdom and by the Overseas Telecommunications Commission in Australia under the name 'Minerva'. When someone in Deakin wishes to send a message to someone in the Open University by this method, he or she logs into Minerva, composes a message, and sends it to Gold.

This direct connection has a price - the Open University recipient has another

computer (Gold) to check regularly for messages, in addition to the University's DEC-20. It is all a bit cumbersome. However, eventually there may be a 'network of networks'; alternatively, a link might be provided between the University computers and commercial electronic mail services such as Dialcom; and finally, suitable 'forwarding' software might be installed on the University's machine, so that it automatically forwards messages to a remote computer.

Distance education in the age of the personal computer

However, while it is the technology that makes things work, what really interests most of us is what we can do with the technology. I will now turn to the possibilities which microcomputers have given to distance educators. I will deal with the various developments under the headings of materials development and production; computer assisted learning; materials distribution; communications, and administration. I will also talk about some of the problems of equiping large numbers of distance learning students and their tutors with microcomputers.

Course development and production

In the old days - say before 1980, academics wrote out their texts in longhand, these were typed by a secretary in draft format, revised through numerous drafts in the light of comments, edited, and either typeset and printed (with the intermediate stages of checking galley and page proofs) or typed in a fair copy and copied by reprographic techniques (roneo, photocopying). However, the use of word processing (either on a microcomputer using a word processing package or on a dedicated word processor) has revolutionised the writing and editing of texts by enabling drafts to be prepared and changed with comparitive ease. (A dedicated word processor is just a microcomputer which is specially designed to do word processing and nothing else.)

Timmers (1986) has described how the Open Learning Institute in British Colombia, Canada established a computer network to facilitate the development of course texts. Each member of the course team was provided with a Rainbow microcomputer, a printer, a modem, communications software and a self-paced training package designed to teach them how to set up and use the microcomputer. The course writers key the text into the machine using word processing software, amend it as they see fit, and, when ready, transmit it electronically over the telephone network to a course assessor, who comments on it. These comments are transmitted back to the author who considers them and amends the text as necessary.

Once the text has been amended, the author sends it electronically to a full-time course developer at the Institute. The latter edits it, transmits the edited version to the author for a final check, arranges to discuss any changes which the author may wish to make by telephone at a pre-arranged time, and, once agreement is reached, re-edits it into its final production-ready form before transmitting it electronically to the production unit. Throughout this process, author, assessor and editor may never meet. Thus, the Institute developed a mathematics course in conjunction with staff at the British Open University and assessed by an academic at the University of British Columbia without any need for a meeting.

Timmers points out that producing a text electronically saves time and improves the way in which people work. The Open Learning Institute monitored the time required to develop and produce a chemistry course where the first half of the course was produced by traditional means and the second half using computer-based technologies. He comments that:

- the nature of the authoring process changed. Also, drafts prepared on a word processor look better than 'scissors and paste' amended manuscripts and are easier to read.
- the assessor knew that the author could incorporate comments easily, so was not as inhibited in making comments as before. The comments made on the word processed texts were far more extensive.
- it was easier and less time consuming for the author to incorporate the assessor's comments.
- electronic communication made it much easier to transmit drafts between the three people involved. There was no lost time waiting for manuscripts to come through the post.
- editing was easier. The text was 'cleaner' and queries and alternative expressions could be inserted into the text sent back to the author.
- the writer was more involved in discussing and agreeing editorial changes
- the time required to prepare production-ready copy fell from 120 hours per page to 50.
- the production unit required less time to produce word processed manuscripts.

Word processing packages can be set up to meet the requirements of the house style, thus reducing the work of both author and editor. Proof reading tools can scan texts for spelling mistakes, vague or anomalous usages, article usage, style, etc. Word processing and graphics packages can be merged and page layouts tried out before printing. Experience at the Open Learning Institute suggests that pre-determined layouts and house styles ('course authoring templates') can speed up

the production process. Computerised typesetting can be used in conjunction with word processing systems, using direct electronic communication or optical scanners for text and graphics. Laser printers can allow authors to produce camera ready copy with merged text and graphics.

At the Open University, course teams are now encouraged to prepare texts on word processors. Whether academics should key in their own texts is a matter of debate, some people arguing that it is a misuse of academic staff time. My own experience is that composing on a word processor is easier than composing on paper, and that as a result keyboard skills are something which all authors needs to have. That being the case, there is probably less need for copy-typists although there is advantage in corrections to documents being keyed in by secretaries who can follow the corrections indicated on hard copies of the draft text.

Computer generated graphics are also produced, particularly in technical subject areas, and these can be merged with the text at an early stage. On the other hand, current limitations in the quality of work produced through graphics packages means that most graphics need to be prepared and put in manually at page make-up stage, so that there is still a need for a set of conventional page proofs to check the positioning of graphics and the quality of reproduction of both text and graphics. Further improvements in the digitization of graphics will mean that increasingly more and more graphics will be produced and stored electronically. The overall design of the course texts can, however, be pre-determined, thus freeing designers to work on the overall design concept and non-routine design tasks.

The production system can accept electronic text either through a network or on disk. This can then be converted to the correct format for a range of outputs, including laser-printed camera-ready copy, phototypeset film, and electronic copy on magnetic tape for use by external phototypesetters. Particular problems are nevertheless encountered in the preparation of mathematics texts where the intention is to produce an electronic output that can be readily converted into the format required for phototypesetting. However, there are packages that can produce good camera-ready copy of complex mathematics using laser printers. The electronic transfer of texts from one system to another needs proper coding from the start. Supervising 'text capture' (i.e. the transfer of text from the point of origination to another part of the network) requires new skills in secretarial staff, and proper training needs to be provided in this.

There is no doubt that these developments are revolutionising the Open

University's text development and production processes. Our best estimates are that the investment we have made in electronic publishing will be paid for within about two and a half years as a result of savings on existing budgets. However, I would be surprised if we did not make other savings, particularly in the use of staff time and hence, ultimately, improve our efficiency either by increasing the volume of development and production of texts or by reducing staff costs or by doing both.

Computer Assisted Learning

Computers are, of course, used to teach students about computing ... but that is hardly the end of the story. They can act as simulators, allowing learners to practise using complex equipment (such as landing an aeroplane); they can act as tutors, patiently correcting a student's work until the student masters a procedure; and they can test comprehension and competence. At the Open University, for example, the computer is used to teach programming and computer studies; for computation; for modelling; for statistical analysis; and as a means of tutoring the students.

Computer assisted learning (CAL) is widely used in industrial training but its use within colleges and universities has largely been as an adjunct to classroom teaching. However, North Island College - a comprehensive community college covering some 80 000 square kilometres of Vancouver Island and the central British Columbian coast with an average population density of 1.35 persons per square kilometre and no urban centres, has used CAL to teach computer science at a distance (Cowper, Godfrey, Hart and Sterling, 1987). The aims of the course were to teach learners to write Pascal code without syntax errors, following through the steps of good problem solving techniques, and developing the ability to select appropriate algorithm and data structure to solve a specific programing problem. Learners had to work through the material with minimal support from tutors, using hardware and software that was initially unfamiliar to them, and in isolation.

The system was based on the College's instructional VAX 750 computer which was linked to VT-100 compatible terminals at three locations via leased lines, a statistical multiplexer and a PACX (Private Automatic Computer Exchange). This made it appear that each terminal was linked directly to the College's VAX 750, although in practice many students and staff shared the same single line. At a later stage these three locations were served by three Optimums networked together, thus freeing time on the VAX for other uses. Smaller and remote communities where it was uneconomic to lease a line were served by 16 bit microcomputers. The CAL element of the course was based on Softwords NATAL which is excellent for

teaching Pascal, does not tie the user to particular hardware, and provides the user with access to a powerful and easy to use electronic mail system.

A great deal of care went into the design of the courseware. Students were to take as much or as little time as they needed to master each section of the course. Testing was to be frequent and evaluative, with individualised grading. Overall, CAL formed the core of the students' learning experience. Each of the 30 units represented a week's work and contained several (2 to 7) lessons from the CAL course, some readings from a textbook, and an assignment that would be marked by the tutor.

The CAL lessons consist of instruction, practise and test material. A lesson is only considered completed when it has been 100% mastered. Lessons cannot be accessed if a prerequisite lesson has not been mastered. However, students can go back to lessons that they have already completed, to refresh their memories. Tutors provide feedback to the assignments. The emphasis on 100% mastery of the lessons meant that students were spending much more than the 150 hours required by a similar course taught on campus. The fact that the course soon acquired a reputation for being a tough one led to a drop in enrolments. Subsequently, the College reduced the number of programing assignments so that each unit no longer had an assignment.

In this case, CAL was being used as the primary means of teaching the course. Within the British Open University, CAL applications are designed to reinforce the students' understanding of the printed course materials. Given the isolation of the distance learner, many of the Open University's CAL applications might best be described as interactive tutorial dialogues - the dialogue between the student and the computer being designed to test the student and enhance his or her understanding of the material (The Open University, 1987). However, CAL has also been used to simulate laboratory or field conditions.

Early evaluations of CAL at the Open University (Jones, 1984) suggested that tutorial CAL was not very successful. This was partly because Open University students had to expend time, effort and money travelling to local study centres to gain access to terminals. Experiments showed that some of these problems could be overcome if students had access to a microcomputer in the home - but providing students with a home-based microcomputer was itself problematic (a point I will deal with later). Lack of success also arose because students were worried by the idea of using a computer (novice users can experience fear and embarrassment, and all

students can have problems logging in and experience machine malfunctioning). Finally, students had an instrumental approach to studying with the Open University which led them to ignore everything which they perceived to be not essential to success. CAL therefore has to be seen as an integral part of the course if students are going to use it.

It is clear that CAL needs to be supported by good documentation and tutors who have been trained and properly briefed and are able to help students overcome their problems. It also helps if nervous students can go along to their first session with someone who is experienced in the use of CAL.

A related application called Computer Managed Instruction (CMI) provides students with computer-generated personalised feedback on assignments - in the form of computer-produced letters. Both the National Extension College in the United Kingdom and Miami-Dade Community College in the USA have made use of this kind of application. A similar kind of application - but in the field of counselling - is found at the FernUniversität in the Federal German Republic where a course on *How to study* is offered in computer-managed mode by gathering information about the learner, and using the computer to manage and individualise the response.

Materials distribution

As the previous section indicated, courseware may be distributed via computer in the form of CAL lessons. However, it is perfectly feasible to distribute course materials such as texts by computer, rather than in printed form.

Kaye (1985) reports on a number of institutions where courses are offered to students via computer. At the New School for Social Research in Manhattan, the largest adult education university in the United States, a number of credit courses were offered on-line through the 'Connected Education' project, using the New Jersey Institute of Technology's EIES (Electronic Information and Exchange System) which, at the time of Kaye's study, was run on a dedicated Perkin Elmer 3230 minicomputer supporting up to 40 users simultaneously. Students had to provide their own microcomputers and modems. Tuition fees covered all computer operating and connection charges with the exception of the (for US residents) local telephone call charges incurred when connecting to the central system. The entire course was taught through computer. That is, apart from reading recommended textbooks, all the students' learning took place via computer. Each course had two "conferences" which students had to join. The first was a 'read only' conference

through which students could access, read and (if they wished) down-load to their own personal computers documents, comments and assignments input into the central computer by their instructor. The other allowed them both to read and write, thus allowing for communication between the student and instructor. Such systems thus allow students to search for and retrieve texts, to write assignments and edit these, and to communicate with other students and tutors by electronic means. (I will return to the communications aspects later.)

Videotex systems also enable students to access information stored in a remote computer via the public telephone network. The information can be displayed on a domestic television set. It is a type of interactive computer system involving student use of a (generally) cheap terminal with characters and graphics capabilities. There is a two-way data-link to the central computer. The user interface is simple and the system, which is standardised by telecommunications authorities, places heavy emphasis on menu selection by numbers and has a fast response time. The unit of response to a command is a screen (called a *page*). Videotex systems have a variety of names - Prestel in the United Kingdom, Telidon in Canada, Teletel in France. Many of the applications of videotex in education simply exploit the fact that the system provides an easy to use information system. On the other hand, some forms of videotex allow a degree of interactivity in which the contents of a particular page may be put together on the spot in response to some impulse - for example, the current numbers of correct answers in some module of a CAL tutorial. Distance teaching institutions which have experimented with videotex include the Open Learning Institute in British Columbia, Canada.

The provision of courses on-line represents a new field which can be exploited by commercial distance education schools and colleges. TeleLearning Systems Inc. is a San Francisco based company which is now offering courses for credit and non-credit purposes through the computer network of its 'Electronic University'. Students have to own or have access to a personal computer. Most of the course materials are provided to students on floppy disks which can be created quickly by the company in response to student demand. The fact that the material is distributed in electronic form means that it can be updated easily through changes to the master disk which are then automaticaly incorporated into future copies on floppy disks. Distribution by floppy disk is reckoned to be cheaper than distribution electronically from TeleLearning's central computer to students' personal computers. On the other hand, it is perfectly possible to store materials on the central computer, and require students to access them by calling the central computer from their own home-based micros. Telecommunications software can then be used to download the materials

from the central to the students' personal computer. If the student wants to have a hard copy, then he or she can create one through their personal printers.

Distribution of textual materials from computer to microcomputer in electronic form - as opposed to the distribution of printed course texts - is therefore possible and may well have economic advantages to the institution, particularly if the costs of students' personal computers and the costs of downloading materials onto students' microcomputers are borne by the student. For example, very considerable savings may be made on the costs of printing, warehousing and distribution.

Progress in this area is contingent on widespread ownership of personal computers and adequate networking. It is also an area where the advantages of hard copy - the familiar feel of well produced pages bound in book form - may cause some resistance to change.

Communications: Electronic Mail and Computer Conferencing

Earlier, I indicated that it was not just the hardware and software aspects of microcomputing that were having an impact on distance education. The fact that microcomputers can be linked together via networks and telephone lines potentially changes the way in which distance teaching and learning is organised.

The development of computer-mediated communications systems (CMCS) which enable messages to be keyed into microcomputers connected by telephone to a central computer allows individuals and groups of people to carry out discussions and conversations over a computer network. Once the equipment, the necessary software and the networking facilities are in place, these discussions can take place regardless of where the people are. The costs of communication are low. Messages can be entered and retrieved at any time, at the convenience of the user. Finally, all communications can be stored until deliberately deleted from the file - a real advantage over face-to-face and telephone conversations - particularly for the forgetful.

The processing power of the mainframe and its CMCS software can be used to organise and structure inputs, outputs and communications patterns in a number of ways, including:

- electronic mail, both one to one and one to many, with automatic signalling of unread mail.
- computer conferencing with the ablity to assign special roles to different

participants (full membership with read and write facilities, read-only membership, conference moderator, conference secretary, etc.) and with different categories of conference (open membership, closed membership, private)

- private notebooks for personal notes and documents
- signalling of on-line participants giving the possibility of synchronous conversations
- membership directories

Kaye (1987a) argues that when applied to distance education, computer-mediated communications systems are quantitatively different from other interpersonal and group communication media and should be seen as a new medium which permits us to do new things, and not simply as an electronic replacement for correspondence tuition, face-to-face tutorials and telephone contact. Thus, for example, in an open conference one can type in a suggestion, or a request for help or advice, and then discover on logging in a few days later that several other, possibly previously unknown, participants have responded with suggestions and ideas. Thus networks of relationships and contacts can widen and develop in totally unanticipated ways. Indeed, there is some evidence that the use of computers by dispersed communities (for example, of research scientists) may actually increase the frequency of other forms of communication because it enables people who might otherwise never have met to establish contact with each other (see Kerr and Hiltz, 1982; Hiltz, 1984).

There have been relatively few reports on the specific use of computer conferencing in conjunction with other media specifically for distance education (but see Davie and Palmer, 1984; Kaye, 1985; Harasim, 1986; Kaye, 1987a; Kaye, 1987b). Most of the applications have involved very limited numbers of students (in the tens) rather than the large numbers which follow some distance education courses. Also, little consideration has been given to the way in which computer conferencing should be integrated into a course, what the effects of its use will be on the way courses are developed and presented, and what the effect is likely to be on the role of tutors.

The problem of scale is easier to solve that the others: a clear distinction can be made between those facilities such as bulletin or notice boards which are seen as one-way and which all students (or all students on a particular course) should be able to read, and those two-way interactive applications such as conferences which may be open only to the students of a particular tutorial group, and where numbers may be limited to at most 20 to 30. The appointment of a data-base editor with the

responsibility for putting new messages into a bulletin board and removing old ones will prevent a bulletin board from becoming too cluttered. Conferences also need a moderator who will undertake a similar job, and also guide the conference and focus its attention.

At the New York Institute of Technology a range of distance study versions of on-campus courses are offered through the PARTICIPATE computer conferencing system. Students receive distance teaching materials through the mail (texts, study guides, etc.) but they can opt for either written correspondence tuition or for electronic communication with their tutor through computer conferencing seminars and private messaging. Assessment is based on either handwritten or electronically written assignments coupled with a mid-course evaluation and final evaluation (Kaye, 1985).

In 1986 the Open University used electronic mail to enable course team members and tutors on the University's undergraduate course on *Cognitive Psychology* to communicate with each other. The system was based on the University's DEC-20 mainframe computer, and used Mail Manager - a professional electronic mail package developed by Stanford University. The tutors and course team members were equipped with Apple Macintosh 512k personal computers together with a Dacom modem (autodial + software programable) and MacTerminal communications software. Communication was through the public telephone network. Electronic mail was an optional extra which enabled tutors to send private messages to each other or post messages on a public bulletin board which could be read by anyone using the system. The course team hoped that the network would speed up and improve communication with and between tutors and that this would in turn improve the general level of teaching. Tutors were given a demonstration of the Mail Manager system. The level of previous experience of electronic mail systems and of Apple Macintosh personal computers was low.

Unreliable access to the system and general problems in using the system put some people off (for example, the shortcomings in the commands used by Mail Manager, the number of times the DEC-20 was down for maintenance - particularly at weekends and in the evenings when tutor usage would have been highest - and an unintelligible - to all but computer freaks - manual for the modem). While initially the majority of users did try to register with Mail Manager, the system fell into disuse by all but the most dedicated, principally because of the lack of reliability of the system and its cumbersome nature. Views on the system polarised with a large group in between who were ambivalent or well disposed towards such systems if

they could be more reliable. In spite of the disappointing start, at the end of the year most of the participants wanted to retain electronic mail and many wished to offer it to a wider audience, including students (Henry, 1986).

Some of the problems encountered in the Mail Manager system do not occur in the simpler, easy to learn and functional COSY conferencing and electronic mail system which was developed at the Guelph University in Ontario, Canada. The Open University began using an adapted form of COSY tailored to its own needs as one of its campus-based electronic mail systems in 1986, with the hope that this would increase interest in electronic mail among staff. In 1987 it began using COSY for course-based computer conferencing. The development of a menu-driven front end to COSY which will automatically log on users, download unread mail, and post messages prepared off-line, should make the system simpler to use. It remains to be seen how tutors on the *Cognitive Psychology* course will react to COSY, but it seems as if the technical problems can undoubtedly be solved.

Integration of computer-mediated communications into an existing distance teaching system raises a number of problems which will probably only be solved through experience. People using the EIES computer conferencing system have found it to be an effective medium for achieving consensus among those working on a common problem or drafting a report. It might therefore be used by dispersed course teams as a means of achieving consensus on course objectives and content, prior to starting writing Groups of students might be asked to work on a joint problem on which they would be assessed as a group rather than as individuals. (After all, there is no intrinsic reason why assessment should always focus on the individual.) Obviously, one way of learning about the practical difficulties and pedagogic potential of computer conferencing is to keep abreast of research and evaluation being conducted elsewhere, but there is nothing like personal experience. Thus plans for a new Open University course (*An Introduction to Information Technology*) for first presentation in 1988 are well advanced. All the students and tutors on this course will be equipped with a personal computer and modem. The design of the course assumes that computer conferencing will be an integral part of the course.

The greatest problem is probably that of motivating people to use a conferencing system. This depends not just on training individuals to use it, but on pursuading them of its value. Successful conferencing depends on all users logging on regularly to read and respond to mail, and to initiate their own contributions; and - in formal conferences - on the presence of an effective conference moderator who encourages

new participants to join in actively, who keeps the discussion focussed, and who provides periodic resumes and syntheses of the progress and main outcomes of the conference (Kaye, 1987a). The experience gained on the *Cognitive Psychology* course in 1986 showed that some tutors were too busy or uninterested to use Mail Manager; others used it a little but with little enthusiasm or some resentment; some were interested in the idea but gave up because of the technical problems; others became regular users and enthusiasts, in spite of the technical problems. The real problem must be to gain the enthusiasm of the second of these groups and engage the first in the conference, in the hope that their enthusiasm will be fired. The next problem will be to distil the experience to discover what it is that makes some conferences successful where others fail, and to train tutors to be good conference moderators. Indeed, the extent to which computer conferencing can be used in distance education will depend to a large extent on the motivation and skills of those who are in direct contact with the students - the tutors - and on their ability to get students to participate in the conferences. (There may be ways of coercing students to do this - for example, by integrating group problem-solving exercises into a course.)

One of the interesting possibilities raised by the introduction of computer-mediated communication systems is that the nature of many distance education systems will change. A distance education system such as the Open University places considerable stress on the careful and pre-planned structuring, processing, and delivery of knowledge and information to students. Computer conferencing, on the other hand, emphasises the individual and allows him or her to develop new and personally meaningful constructs of knowledge, and negotiate these with other individuals. In a democratic and relatively status-free environment, there is scope for peer teaching and for students who happen to know far more about certain aspects of a subject than their tutor to take a lead. Thus Boyd (1987) sees computer conferencing as permitting "liberative discourse" and Feenberg (1986) stresses the importance of the moderator's role in " ... encouraging personal viewpoints and diversity of opinion rather then ... offering authoritative solutions to the problems posed in the course". The corrolary of this is that students with wrong or mis-conceived notions about the subject can propogate them easily, thus possibly misleading others.

Administration

At present most student administrative processes (for example, the registration of students on courses or an alteration to a student's record - such as a change of

address) take place in response to the administration's receipt of a form which the student has completed and sent in. Clerks read the form, check it, and make the appropriate change to the student's record.

There is no reason in principle why students should not be able to use a home based microcomputer and some kind of simple interactive menu type system (such as videotex) to indicate their own choice of registration on courses or the residential school which they would find it most easy and convenient to attend, to change their address, or to request a particular service (for example, the loan of a video-cassette). The opportunity could be taken to provide simple advice to students - for example, in a system such as the Open University's where students can take virtually any course in any order, to suggest that they take a course that is a recommended pre-requisite before embarking on their first choice of course.

Such a system would reduce the delay inherent in posting forms to a central administrative office, and greatly reduce the amount of clerical effort required to maintain a student's record. Some of the requests (for example, the request for the loan of a particular video-cassette) could trigger the production of a computer printed label which indicates what the student has asked for as well as printing his name and address, and this could then be stuck onto an envelope into which the appropriate cassette could be inserted. This would be quicker than opening a letter and having to read and interpret it correctly. Considerable savings in staff might arise from such systems.

However, such a system would depend on all students having access to a personal computer which was linked to the administrative mainframe computer. This leads naturally to the last problem which I wish to consider - how can one ensure that all students have a personal computer.

Getting things going: equipping students and tutors ...

One of the major problems facing any institution which is trying to capitalise on the educational and administrative possibilities of microcomputing is the problem of equipping staff and students with personal computers which are easily available, simple, convenient to use, and inexpensive.

The Open University's experience is that this is by no means easy. From the very start, it seemed clear that the ultimate objective should be to equip every student with a personal computer. Students would benefit by having access to certain

standard software packages (word processing, spreadsheets, etc.) which would halp them irrespective of the course they were studying. With a modem and a communications package, they would be able to participate in computer conferences. Students on a range of courses would use the co. iputer as a computational, organisational, and modelling tool, while those studying computing would use it to gain hands-on experience of computing.

In the first stage of this project, the University has concentrated on meeting the needs of all courses planned for 1988 and thereafter where it is essential that students have hands on experience of computing. Subsequently it will extend the policy to cover courses where it is desirable that they should have such experience. Only then will it begin to require all students to have a computer.

To give some idea of scale of the immediate provision that has to be made, the University estimates that in 1988 there will be 4500 students following courses where computing is judged to be essential, rising to 12 750 by 1990.

Past practice at the Open University has been to provide students with the equipment they require to study a course where this is course specific. Thus the chemical and electronic equipment and apparatus required to conduct scientific experiments on some courses is provided to students on loan. In the past this has included a small personal computer which was specially designed to meet Open University requirements (the HEKTOR). By the early 1980s, however, it was clear that this policy would no longer meet the needs of main line computing courses, and that, unless a satisfactory machine could be provided, the University faced the possibility that it might have to withdraw from teaching computing. It was also clear that the scale of provision was such that the University could not afford to provide enough of its students with computers. Since students are already required to equip themselves with television sets, audio-cassette players, etc., no new principle was involved in asking students to provide their own microcomputers. However, there were considerable cost implications for students.

The University set out to discover what proportion of students already owned a computer. The results of this study suggested that while many students had a computer, this covered a wide variety of machines. Thus the first task the University had to do was to choose a computer which it would recommend to its students. No sooner had this been agreed than the problems of doing so became apparent. The plan was to introduce the requirement that certain students should equip themselves with a computer by 1988, yet early in 1985 and within the context of a fast moving

industry it was not clear whether existing computers would still be on the market by 1988; computer manufacturers were reluctant to give this assurance; nor they could give guidance on what new machines might be on the market in 1988, let alone in six months time. As a direct result early attempts to identify a specific University-recommended machine collapsed. The University therefore decided that, rather than adopt a manufacturer specific machine, it would base its specification on technical requirements. It adopted the MS DOS operating system, 512K RAM memory, minumum 512K disk storage, a black/white monitor, a pointing device, and a printer, - i.e. an IBM clone - as the requirement. The specification laid down that the machine should have a VT 100 communications capability. Where access to a mainframe was required, the University would loan students a modem.

In the long term it is assumed that students will be responsible for ensuring that they have access to a computer with these capabilities. In the hope that significant numbers of students will want to buy their own machine the University negotiated with suppliers to provide a machine which would meet its specification at a reasonable price to students. In the short term it recognised the heavy financial burden which students would face at a time when home ownership of personal computers is not widespread. It therefore obtained a grant from Government to buy a stock of machines which would be available for rental to students who did not wish to purchase a machine, and a further stock which would be loaned to students who were financially disadvantaged. Two machines have been acquired for student rental - the Amstrad PC 1512 and an Akhter PC clone. A few backup machines will be sited in local study centres. The University expects this specification to last for two years; it will probably be revised for courses due to be presented for the first time in 1990.

As far as software goes, the specification includes GEM (graphics environment), with course specific software and where appropriate a range of utilities such as word processing and spreadsheet packages (for example, 1st. Word Plus, Lotus 1-2-3, DCA Easy Base).

Research into how the programme may develop in the future continues. Alexander (1986) has prepared a project proposal which envisages equipping students with a high-performance, low-cost workstation with a keyboard, a good pointing device such as a mouse, an A-4 sized high resolution screen, sufficient hardware and software so that graphics can be easily generated and modified, fast response time, multiple windows to enable rapid switching between tasks, iconic symbols and pop-up menus to avoid the need to memorise commands, and

appropriate communications to the University's mainframe. While his proposal provides an exciting vision of the future, it is unlikely that the University will ever develop its own home computer again. The most promising line of development for the University undoubtedly lies in the development of software which will meet educational needs and facilitate communications.

Conclusions

The first thing to say is that microcomputing is changing the face of distance education.

I have indicated that the way in which printed course materials are developed and produced is changing, with all the attendant advantages of increased flexibility and savings on costs and time. Increasing numbers of distance teaching universities are availing themselves of the benefits of electronic publishing.

Already some distance teaching institutions are delivering course texts in electronic form, and while this practice is not as yet widespread, it may well become more common.

The use of CAL is increasing, and appears to be successful. A number of distance education institutions use CAL as an adjunct to more traditionally delivered and taught distance courses, but some have made it the main medium of instruction. Videotex systems hold out possibilities which are now being exploited in the form of Computer Managed Instruction systems, and it seems more than likely that these techniques will eventually be widely applied to administrative processes, with consequential savings in time and staffing requirements and increased speed of response to student needs. However, this will depend on universal access by students to personal computers that are in turn linked into the institution's administrative mainframe computer.

Ownership of a personal computer is now a pre-requisite for entry to some institutions of higher education - for example, Carnegie Mellon University in the USA. Students need access to personal computers and to the power of a mainframe in order to study an increasing range of subjects, while all students can benefit from using general computer-based utilities such as word processing and spreadsheets. Nor is this requirement just the preserve of higher education. The real challenge which distance education institutions face is how to get personal computers into the hands of a dispersed, home-based student population of - potentially - many

thousands. I have indicated the strategy that has been adopted by the British University - but we have a long way to go before all of the University's 80 000 students on first and higher degree level courses are equipped with personal computers - let alone the 40 000 short course students who pass through the University each year.

The most significant effect of personal computers, however, is likely to be on the way distance education is organised, and in particular on the pattern of communications which take place between students, tutors and central staff.

Obviously, one consideration which I have not as yet mentioned is that of cost. There are enormous cost implications implicit in a decision to invest in a home computing strategy. The development of computer assisted learning materials is very expensive: Scanlon et al (1982) estimated that it required from 2 to 4 professional person-months to develop one hour of CAL; Sparkes (1984) estimated 200 or more hours of work to prepare one hour of student learning by CAL. Electronic publishing involves a prior investment in equipment, networking and training - although the consequential savings arising from the investment should pay for the move to electronic publishing within two to three years. The greatest cost is the cost of equiping students with personal computers and communications facilities. Since few if any distance education institutions could afford to equip their students, there are also cost implications for students. It is possible that those forms of distance education which exploit two-way, electronic, means of communication will become so expensive that only the relatively rich can participate in them, while the relatively poor will be left with forms of distance education that are reliant on mass media that are in general one way means of communication, coupled with correspondence tuition and some face-to-face contact. On the other hand, once students are equipped with personal computers, a further investment in the electronic administration may reduce the costs of administering students at a distance. Electronic distribution of texts will also reduce costs - for example, a recent advertisement from a publisher offered a management guide to contracts at £250 in two-volume loose-leaf printed form or £125 on disk.

Exploiting the potential benefits of microcomputers for distance education is not easy - but I believe that the benefits are there for the taking - and, before another decade has gone, I confidently expect to see very significant changes in the teaching practice, administration, organisation and cost structures of distance education systems. All of these changes will arise as a direct result of the extended use of microcomputers in distance education. We live in exciting times.

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