

COMPUTER SCIENCE, HOME COMPUTING AND DISTANCE LEARNING

- THE LARGEST COMPUTER SCIENCE COURSE IN THE WORLD?

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Abstract

This paper describes the introductory course in Computer Science produced by the United Kingdom Open University. The course has a study time of 400 hours and is innovative in that all students must provide themselves with a Personal Computer. Access to the University is open in that students are not required to have attained any particular level of education before being admitted to the university; entrance is awarded on a first come first served basis. Students study at home and many are employed in full-time jobs. The course is very popular and over 2200 students took the examination in 1988, suggesting that it is indeed one of the largest courses of its type.

The paper also discusses the important logistical and academic problems of providing materials for several thousand students to study using their own machines at home.

Keywords

Home computing, Distance learning, Microcomputer, Program template, Teaching of programming

1 INTRODUCTION: WHAT IS DISTANCE LEARNING?

A good definition of distance learning is provided in [1], "the various forms of study at all levels which are not under the continuous, immediate supervision of tutors present with their students in lecture rooms or on the same premises, but which, nevertheless, benefit from the planning, guidance and tuition of a tutorial organisation". The United Kingdom Open University was one of the first to provide university level education by distance learning, although there are now many institutions all over the world that use a distance learning system as a basis for provision of their education and training.

A distance learning system combines the use of different media, such as specially prepared texts, radio and television broadcasts, video and audio cassettes, together with a support system in the form of a tutor who will give some face-to-face tuition, but who is also available by telephone for more immediate assistance. The system is flexible, providing a modular structure linked to a credit system and, depending on the targeted student population, provides open access to education and training that would not normally be available.

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The course materials are prepared and produced by a 'course team' comprising an academic Course Team Chair, other academics, a BBC television producer and assistants, a graphic designer and illustrator, an administrator and a media specialist. The Course Team Chair takes responsibility for all academic decisions and together with the administrator, steers the course through all stages of its production, a process which lasts about three years. The high volume of production of learning materials, together with the students' self-motivation to study in their own time and at their own expense, means that distance learning can be a more economical method of education and training than the traditional face-to-face tuition. Several companies in the UK are now using distance learning as part of their corporate training programme and the University has already produced courses to meet this particular need.

2 THE COURSE

Since 1973 the number of students taking Open University Courses on computing has increased dramatically, as a result of the increased number of courses and the growing importance of Information Technology in general. For example, the most popular undergraduate course in this area is Fundamentals of Computing which is currently attracting over 3000 students each year. This is a 400 hour (i.e. year long) introduction to computing, and it is designed for the complete beginner who has no experience of computing. The course is a pre-requisite for the University's other courses in computing, such as Programming Languages, Software Engineering and Data Modelling and Databases. The aim of the course is to teach basic Computer Science concepts and not programming *per se* although UCSD Pascal is taught as a vehicle for this. The emphasis is on top-down design and structured programming, but other topics such as software engineering, database systems and operating systems are included. The course is multi-media in that the student receives printed materials, audio-cassettes and is expected to watch television programmes.

The Texts

Each student receives 30 texts produced to book quality specification and studies one of these texts each week. This is called a unit of work and it is expected to take the student about 12 hours to study. The course is structured into six blocks of five units and the titles of the blocks and their units are as follows:

	Block I - First Steps
Unit 1	Introduction
Unit 2	The UCSD system
Unit 3	Problem solving
Unit 4	Further design considerations
Unit 5	A look at data structures
	Block II - Control Structures and Arrays
Unit 1	One dimensional arrays
Unit 2	Sorting and searching
Unit 3	Looping and conditions
Unit 4	More on types
Unit 5	Syntax and sets
	Block III - Modular Design
Unit 1	Introduction to modular design
Unit 2	Procedures and functions
Unit 3	Scope and separate compilation
Unit 4	String processing
Unit 5	An introduction to software engineering
	Block IV - Data Structures
Unit 1	Static structures: arrays, records and tables
Unit 2	Sequences: static storage
Unit 3	Sequences: dynamic storage
Unit 4	Tree structures
Unit 5	Recursion
	Block V - Information Systems
Unit 1	Sequential files
Unit 2	Direct files
Unit 3	Indexed files
Unit 4	Data modelling
Unit 5	Database systems
	Block VI - Wider Horizons
Unit 1	Operating systems 1
Unit 2	Operating systems 2
Unit 3	Software design
Unit 4	Software management
Unit 5	Some social implications

Television

Sixteen television programmes have been produced by academic staff of the Open University and staff of the BBC Open University Production Centre, a large television production facility on campus at Milton Keynes. The television programmes are broadcast on national BBC television at fortnightly intervals. The programmes are of three types, but all are produced to BBC broadcast standard and are indistinguishable in quality from other BBC programmes. The simplest and cheapest to produce are studio-based programmes which teach a particular topic of the course or provide extension material. They consist of a combination of informal direct teaching, graphics, and magnetic boards brought together by high quality video editing. Top-down design, multi-programming in operating systems and pointer variables have been treated in this way. The second type of programme takes a topic from the text and shows how it is applied in a real world practical example. As location filming is required in addition to graphics, these programmes tend to be more expensive. The use of data structures and modular design are examples of topics which are illustrated in this way using the

point of sale computer system used in the retail outlets of The House of Fraser, the owners of Harrods. Finally, there are programmes which are not related to the course materials specifically but are intended to increase the awareness and broaden the students' appreciation of the world of computing. Such topics as computing on the Nasa space shuttle, the human computer interaction work of the Federal Aviation Authority and an expert system for tyre quality control at Pirelli Tyres have been covered in these programmes. These latter two types of programmes show real world computing applications and they are intended to give students an appreciation of the scale and problems of designing, running and maintaining real computing systems.

Audio-cassettes

Audio-cassettes have been used extensively in the teaching of mathematics and in this course they are used in a similar way. In general, the tapes contain a commentary which is used to explain complicated diagrams that may extend over more than one page. Students listen to the tape commentary while looking at diagrams in the text. The commentary explains the diagrams in detail. In one example various forms of loop construct are explained, while in another, a long Pascal program is analysed procedure by procedure with the commentary highlighting the various parameters and the flow of control through the program.

Practical Work

It is essential for a course of this nature to have practical work, requiring access to a computing facility. On previous courses, students had to attend local centres and book time on a terminal connected to one of the University's mainframes. As all students must provide themselves with access to a personal computer, it is possible to ensure that they received adequate practical computing experience. The specification for the machine is essentially a single disk hardware configuration that can run MS-DOS and the University guarantees that its software will run on a machine that meets this specification. Students either buy or rent a machine from the University on which to do this work. Each student is sent out 10 floppy disks containing software prepared by the course team and one containing the UCSD p-System. In total over 400 files are provided on these disks, most of them being courseware provided by the course team. There are different kinds of files prepared for the course and each type is given an identification code prefix.

The majority are programme templates. This idea was developed by the course team to reduce the amount of typing that students had to do in order to complete their practical computing exercises. This was considered to be a very important aspect of the course design since it is well known that novices who are unfamiliar with keyboards as well as the Pascal syntax are very slow at entering programmes and also make many trivial errors which cause their programmes not to run. In addition these students study part-time and so time is very precious to them. The templates were designed so that the students only have to complete the part using the relevant concepts which had just been taught. The students also use link files and UCSD units in combination with the templates. For example, units were used to initialize arrays with data. The ability to use previously compiled UCSD units was the main reason why the UCSD p-System was chosen for the course. Development of the course and the associated software began in 1985 and, at that time, no other system provided this facility. Given the lengthy lead time and production time for the course, it was not possible to change this decision at a later time. Completed templates, that is answer files were also included for some exercises so that students

could check their own programme construction. Simulation programmes were also provided so that students could explore some computing concepts in this way.

Assessment

The course assessment consists of 8 assignments which are posted to the student's tutor to be marked. Several of the assignments require students to produce Pascal programmes from which they have to obtain a listing and a sample run to send to their tutor to be marked. Tutors and a help-line at the University are available and can be contacted by phone at specified times if help is needed. At the beginning of the course many students used this facility as they worked through preliminary material designed to familiarise them with the system itself and with the Pascal language. As the year progressed these facilities were used less. The year ends with a three hour written examination which is taken in one of the many examination centres rented by the University throughout the country. In 1988 the exam was taken by more than 2200 of the originally registered 3000 students.

3 PROBLEMS

There is no doubt that in 1988 the course was a great success and there is no reason to suppose that 1989 will be any different. In 1988, about 5000 students took courses that required a home computer; in 1989 the figure has risen to over 10000. The courses provided range from dedicated 'computing' courses to technology courses where the computer is seen as an essential tool.

Student reaction is generally very favourable in spite of the fact that students have to bear the cost of the home computer themselves. To assist with this problem the University has a pool of machines available for hire. The relevant figures for 1988 are:

Purchased from OU	26.9%
Hired from OU	38.3%
Arranged own access	34.2%

This latter category includes those who already had access to a machine, either at home or work, and those who purchased elsewhere. Most students purchased a machine which was of a higher specification than the minimum recommended configuration. However, it is believed that home computing has changed the 'openness' of the University in that students may decide not to take a particular course because of the additional cost. Thus, there is a fear amongst staff that less well-off students are deterred from taking courses for which a personal computer is required. This may also encourage discrimination by gender since far fewer women have jobs in which they have free access to a suitable machine. The University is concerned about both these aspects and is currently investigating them.

Of those who took the courses several felt that they had made a significant financial outlay for the use that would be made of the equipment. Furthermore, it is likely that some students who previously would have tried a course on computing, as a one-off course, may now be prevented from doing so solely on financial grounds. The whole question of finance for home computing is therefore a serious one.[2]

Another interesting aspect of home computing in the distance learning environment is the extent to which the practical work on the computer is integrated with the text. Students often take the opportunity to study when they are away from home, such as when travelling or at work. It is clear that when the use of the computer

is closely integrated with the text then this study pattern is not so convenient. Students who use a machine at work often find that they cannot devote enough time to the practical work in the time slots available at work. It is essential that study guides to course make the point that access to a machine at work may not be sufficient for the student to take full advantage of the course.

With the advent of home computing it was necessary to be extremely careful to check all the software thoroughly and to carry out stringent quality control to ensure that all the disks and the software on them were correct; with such a large population of students even quite small errors could have caused enormous problems. Any bugs in the software could only be reported to the students and would be fixed for the next year's intake. Previously, with the software on a mainframe, software bugs could be corrected immediately. The software for the Fundamentals of Computing course consisted of over 400 files, all of which were subject not only to a rigorous software quality control check, but also a check against the relevant textual material. The resource required for this operation should not be underestimated. Similarly, the resource required to reproduce 40,000 disks for just the one course necessitated an investment of both machines and human resources.

A side-effect of the move to home computing has been the loss of a communication facility with the students. Only one course now requires the use of a modem and connection via the public telephone system. The high telephone charges, borne by the student, are not popular and again may result in a loss of 'openness'. From the institution's point of view, the inability to correct software instantly can be a problem and is a direct result of home computing.

In the next year or so the specification for the personal computer will change to reflect the change in technology. One of the home computing courses attracting 1500 students, already requires a modem, which the university provides, for access to a conferencing system. The new course on Databases will require a twin disk system and again financial support for some students will be provided by the University. The new specification is likely to include a hard disk, but will be compatible with the current systems. It is likely that two or three consistent and progressively more ambitious specifications will be provided so that students will have a clear idea of the direction in which the University is moving. Those students who have the necessary interest and finance can then invest in equipment with more confidence.

4 SOME CONCLUSIONS

As we have already said the Fundamentals of Computing Course has proved to be an outstanding success. However, teaching computer science by distance learning to such large numbers of students is not without its problems and interesting challenges. The issues that we have raised in this paper fall into two categories: logistical and academic issues.

Logistical issues include the need for students to obtain their own computers. For the students this means extra financial outlay. For the University it raises the question of financial discrimination in an institution founded on the philosophy of 'openness'. There are also obvious problems in selecting and updating equipment and insuring that disks and their contents are both technically and academically correct.

On the academic side there is the problem that all tertiary education in this field faces, deciding what the curriculum should be and

keeping up-to-date when technology is changing fast. This problem is, of course, exacerbated by the numbers of students involved and the 'lead-time' to produce distance learning materials. Many decisions will have to be reviewed when the course is updated in 1992. For example, what programming language should be taught and also how much should a foundation course reflect some recent trends in computing science and related disciplines, such as parallel processing, AI, HCI etc.

References

- [1] Holmberg, B. Distance education - a survey and bibliography. Kogan Page Ltd. 1978.
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Appendix

The Open University in the United Kingdom (UKOU)

The United Kingdom Open University (UKOU) is the largest university in the United Kingdom and has considerable experience in teaching undergraduates by distance-learning methods. The UKOU enrolled its first students in 1971. 50,000 students now hold BA degrees from the UKOU and currently there are 100,000 students studying with it. The courses offered include those which lead to a BA degree, short non degree courses and post-graduate level courses. A BA with honours may be awarded to a

student who has accumulated 8 credits, where a half credit course is equivalent to approximately 160 hours of study. The University has a policy of "open" admission, which means that students do not need to have any academic qualifications in order to study with the OU. Most of the tuition is by distance teaching which requires students to study correspondence texts and listen to TV and radio broadcasts in their own homes. This form of tuition enables many students to study at home whilst still retaining full time employment.

The UKOU is organised from a central campus situated at Milton Keynes, 60 miles North West of London. The academic facilities are situated on this campus and it is here that course teams work to produce the courses. Most of the administration is also organised from this campus. There are two large main frame computer systems, one is used for recording students' data and carrying much of the University's administration and the other is used to provide a computing facility for staff and students. TV and radio production facilities are also available on this site, housed in a purpose-built BBC building. As well as the central campus, there are 13 regional centres which administer local tutoring and counselling provision, organise examinations and provide local liaison between and central campus, students and tutors. Each regional centre directly controls a number of study centres. There are 260 study centres in total, located throughout the British Isles. Each study centre provides a venue for tutorials and contains audio-visual equipment and a point of access to the Open University mainframe computing facilities at Milton Keynes and Newcastle.