VIDEODISC TECHNOLOGY AND MATHEMATICS EDUCATION

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During the eighties there has been a growing consensus (Cockcroft, 1982; HMI, 1985) in the U.K. on how mathematics teaching should be approached in secondary schools. One of the central features of this is the agreement that mathematics should be presented in a problem solving context and that, wherever possible, this should involve real situations. For many teachers, however, addressing such reality is problematic, their attempts to do so being seen by children as somewhat contrived and artificial. Much of the curriculum support material which has been developed in recent years has attempted to address the issue by providing real life contexts, but the projects have met with only limited success.

> Many have urged us to stress that mathematics courses for these pupils should be 'relevant to the requirements of everyday life'. However this aim is easier to state than to achieve. For example we read in the report of the National Secondary Survey (Her Majesty's Inspectorate, 1979) that 'it was very common for the schemes of work in the schools visited to refer to the need to relate the mathematics taught to the problems of everyday life, but the convincing realisation of this aim was much more rare'.
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> (Cockcroft, 1982, para. 459)

One answer to this difficulty would appear to lie in the development of interactive video (IV) material which combines the benefits of moving and still video pictures with interactive computer software. Although the main IV developments to date have been in the area of training rather than education, the writer would suggest that there are exciting possibilities for IV use in mathematics classrooms. IV has the capability of bringing real mathematical situations into classrooms where young people can interact with the material in a way which will enhance their understanding of mathematics because of the meaningful way and the real contexts in which mathematical concepts are presented.

This paper describes the technological aspects of interactive video and considers the current position with regard to IV development in mathematics education.

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INTERACTIVE VIDEO

Interactive video combines the visual realism of television with the interactive characteristics of computer based learning. The program demands the participation of the learner by asking questions and presenting him (or her) with choices at appropriate points. Thus, the user can explore particular interests, test his own comprehension and reinforce areas of weaknesses or difficulties, his reactions determining the ensuing pathway through the material.

(Department of Trade and Industry, 1985)

IV incorporates computer assisted learning and audio visual presentation in a single medium. The computer system comprises a microcomputer fitted with special chips and interfacing devices and linked to twin disc drives. The moving pictures and stills are stored on either videotape or videodisc and are displayed on a special monitor. At the present time the hardware system is somewhat cumbersome and difficult to assemble, but it is anticipated that as the technology develops more compact, dedicated IV hardware will be available. Videodisc systems, while considerably more expensive than videotape systems in terms of hardware requirements and courseware development costs, have the advantage of offering virtually instantaneous speed of access to a large amount of still and moving material. Picture quality is very high and when laservision systems are used, as opposed to the alternative Video High Density (VHD) technology, there is no disc wear and therefore no loss of picture quality with repeated use. The learner interacts with the material either through the computer keyboard or by using a mouse or trackerball. It is also possible to incorporate light pens, touch screen monitors or, in the most sophisticated systems, voice recognition devices. Learning with IV is active in that the moving pictures are not presented in a linear fashion as with conventional video, since the order of sequences is determined and controlled by the learner through the computer.

A single sided laservision disc can hold up to 55,000 still frames or 37 minutes of moving pictures (or various combinations of both). When linked to computer software a single videodisc can provide several hours of study. A particular disc can be used for a variety of classroom approaches (individualised, small group or whole class use) and for a range of age and ability levels, the different modes and levels being determined by the supporting computer software provided that the picture sequences and contexts are appropriate.

The Council for Educational Technology (CET) has identified 4 distinct modes of IV use:

Mode 1: for whole class use, controlled by the teacher.
Mode 2: for small groups of up to 4 students, with little teacher-pupil interaction.

Mode 3: for individualised use.
Mode 4: as a resource data base, which can be accessed by teachers and pupils.

IV allows the learner the opportunity to make decisions which then determine the picture sequences which follow. The learner is therefore able to appreciate the consequences and implications of those decisions. Role play is possible so that the learner becomes intimately involved with the material and in this way IV approaches a level of reality which is difficult to envisage with any other learning medium.

THE PRESENT AVAILABILITY OF MATHEMATICS VIDEODISCS

In the U.K. little videodisc material is available for education generally, and the writer is aware of only two videodisc packages planned in the area of mathematics education. The Interactive Video in Schools (IVIS) scheme[1] has funded eight projects in a range of curricular areas. These projects are currently at the trialling stage with all eight discs now pressed. One of the IVIS projects is a mathematics disc produced at Exeter University. The disc, aimed at fourth and fifth year secondary students, looks at planning a disco and involves the learner in decision-making based on the mathematics required. A range of mathematical topics are included: basic arithmetic, statistics, graphs, modelling and optimisation. It is intended that the disc be used in several different ways: with individuals, small groups or a whole class. The Interactive Learning Project (ILP), based at the School of Education, University of Newcastle-upon-Tyne, is developing three learning packages which include videodiscs, two in physics and one in mathematics. The mathematics disc deals with the pre-formal stages of learning probability and is pitched at 11 or 12 year olds, but is to be adapted through software design for use with 14–16 year olds and sixth formers. The mathematics team at Newcastle is attempting to immerse pupils in situations which will allow them to develop an intuitive feeling for probability before the pupils meet a more formal treatment. The process is open-ended and investigative where the learner is placed in a world of real experiences over which he or she can have control but can also experience the effects of decisions made by others.

In the U.S.A. there has been considerable videodisc development for use in the mathematics classroom. For example, Systems Impact Inc.[2] have produced videodiscs in the areas of fractions, decimals, percentages and ratio, and are developing an algebra disc. The videodiscs are described as "comprehensive mini-courses for group-based instruction" and are therefore designed for a Mode 1 level of interaction. The packages are seen as a series of skill-building programs which offer "a carefully constructed sequence of lessons in a fast-paced teach-review-test format, allowing continuous assessment of student programs". Systems Impact's advertising literature describes the teacher's role in a programme which is designed to fit into a mastery learning model:

> Using a videodisc player, which includes a remote control keypad, and a colour television or monitor, a teacher can instruct classroom after classroom of students, assured that each lesson is presented effectively and paced for student mastery of the concepts. The remote control allows the teacher to move freely throughout the classroom – diagnosing student progress and monitoring classroom performance as the lessons are presented via the videodisc. Branching to a particular segment to illustrate a point or remediate performance can be done easily and quickly by the teacher from anywhere in the room.

The following comment from a fifth grade mathematics teacher in a school in Logan, Utah illustrates the appeal of the Systems Impact approach for many teachers:

> Before I used the videodiscs, I spent a lot of my time with my back to the students writing maths problems on the chalkboard. Now, I can walk around the room and observe and assist each individual student's progression. Now, teaching is delightful.

It is important to point out that the Exeter and Newcastle videodiscs in mathematics are much less instructional than the U.S. model described above, and are not seen as mainly class-based videodiscs, but are designed primarily for Mode 2 and Mode 3. The trialling results of the Systems Impact discs in the U.S. have been highly encouraging, with high levels of student mastery and significantly better gains obtained by students who used the disc rather than the conventional programme. There was also evidence of better student attitudes towards these mathematical topics when taught by videodisc. The initial field test results on the fractions, decimals and percentages discs which were tested in Oregon schools led to the following conclusions:

1. High levels of student mastery can be consistently expected. In grades five through eight, one can expect each of the core maths concepts to be mastered by at least 90 per cent of the students.
2. Student gains occur uniformly across high and low achievers.
3. When the program was compared with the traditional program, the videodisc program produced gains that were both substantively and statistically better than the conventional program.
4. All indicators of student interest, including attitude questionnaires and direct observations of student attention in class, strongly supported the observations that students' interest increased as a result of the use of the videodiscs. The data also suggested that this interest was maintained and was not due to a novelty effect associated with the technology.

(Hofmeister *et al.*, 1986)

While the mastery learning model is often criticised by educationists in the U.K., it must be recognised that any learning package which addresses the potentially difficult and often unattractive areas of fractions, decimals and percentages and achieves success as claimed above, must be given serious consideration. While the writer would argue that such an approach does not appear to lie within the spirit of mathematics education development in the U.K. post-Cockcroft, it is nevertheless clear that the Systems Impact discs have achieved the stated objective of "increasing achievement in those mathematical skills important for successful employment in modern industries".

It is more likely that U.K. videodisc developments in mathematics education in the short term will focus on the need to deal with real mathematics through investigative and practical work and problem solving. The writer would argue that it is in these areas that the true and exciting potential of the medium will be realised.

FURTHER DEVELOPMENT

There would appear to be a number of fundamental issues which must be considered by those engaged in projects which are developing these materials. It is questionable whether schools will be able to purchase the hardware which is necessary if there is to be a widespread development of IV. At the present time, a BBC microcomputer system could be upgraded to an IV station at a cost of approximately £1500. Courseware development costs are high: £100,000 per disc is not an unreasonable estimate. The acceptance of IV will undoubtedly be determined by the quality of the courseware that is produced and the onus is therefore very much on the development projects to convince the teaching force that IV offers possibilities unrivalled by other approaches. This may prove problematic at a time when, for a variety of reasons, the microcomputer is under-used as a resource in a majority of mathematics departments.

Class management issues are also raised by the introduction of this technology. It is unrealistic to assume that schools will have large numbers of videodisc stations and therefore if courseware is designed for small group use, careful consideration will need to be given to classroom organisation. It may be advantageous to consider a videodisc as part of a much larger materials package which could also include pupil worksheets, traditional computer software, linear videotape material and other supporting material. The question from teachers of "what do I do with the other 25 pupils?" is predictable and must be addressed.

The question of how children react to this new technology and how they learn mathematics from it is of fundamental importance to mathematics educators. A thorough, longitudinal evaluation will be necessary before any conclusions can be drawn as to whether the presentation of mathematics through this medium is able to significantly enhance children's understanding and enjoyment of the subject.

At this stage, therefore, the writer would only tentatively suggest that this technology has the potential to help mathematics teachers present a wide range of mathematical topics in a meaningful and more interesting manner. Much of the mathematical diet in secondary schools is seen by teachers as essentially dull. Videodisc technology can help overcome this by bringing real-life applications into the classroom along with the requirement to engage in appropriate problem solving and decision making. The opportunity to then see the consequences of those decisions represents the most powerful use of this learning medium. Videodisc technology is possibly the most effective resource currently available for presenting mathematics in an applied context.

NOTES

[1] Interactive Video in Schools (IVIS) Project, 24–32 Stevenson Way, Euston, London, NW1.
[2] Sytems Impact Inc., 4400 MacArthur Blvd. N.W., Suite 203, Washington, D.C. 20007.

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