The Reality of the Computer in the Classroom

compiled and edited by David Tall

In this session those present attempted to get a picture of what was currently happening with computers in "typical" classrooms around the world. We were very much aware that this would be a transient and speculative activity, nevertheless we felt that it would be valuable to focus on the problems facing the typical teacher in classrooms other than those involved in much heralded experimental work.

The session began with short reports from several different countries, followed by the opportunity for discussion in smaller groups before returning for a full group discussion. A questionnaire was also circulated around those present to obtain information on their own personal use of the computer in the classroom.

Reports from different countries

United Kingdom — Martin Perkins

(Martin Perkins teaches in a small selective boys' school (600+ pupils aged 11-18) in the south-east of England and was a member of the Mathematical Association subcommittee on "Using the Computer in the Secondary Mathematics Classsroom".)

In 1986 the Mathematical Association conducted a small survey on the use of computers, since when there is no evidence that the situation has changed greatly - the upheaval caused by the new examining system at 16+ (The "General Certificate of Secondary Education") has been the central focus of recent developments.

The survey covered some 50 secondary schools known to members of the committee (including most types of secondary school in the U.K.) and might therefore have been expected to produce a slightly optimistic picture. (A broader Government survey at about the same time indicated similar trends with lower positive results.)

On average there were 16 computers per school - about one for every fifty pupils. 58% of the computers were networked in general-purpose computer rooms and only 5% were in "mathematics rooms" (i.e. about one per 1000 secondary pupils).

Teachers responded that they used the computer as follows:

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Never: 33%, Very Rarely: 39%, Once a week: 15%, Often: 6%, Very Often: 6%.

Most commonly they used the computer for class demonstration and for investigations/problem-solving, but even these were still only in the "very rarely" category.

The factors inhibiting computer use were summarized as follows:

Difficulty	Never	Sometimes	Often	Always
Lack of Software	8%	21%	65%	6%
Lack of Computers	19%	27%	37%	17%
Syllabus Constraints	31%	23%	37%	10%
Lack of Training	29%	33%	31%	8%

In April 1988 the Minister of State urged industrialists to provide financial support to increase the number of computers in all schools (primary and secondary) from one to every four classes up to one to every three classes. Even when the lack of hardware has been overcome there will still be the problem of software. In the early stages there was little good software for mathematics. Now that a wide range has been produced, the problem is that teachers do not have the time to gain the experience actually using computers, or the expertise to review software to determine its quality and suitabilty for their classrooms. There is much to be done, but at least a start has been made.

Denmark **Ulla Kürstein-Jensen**

(Ulla Kurstein-Jensen is a teacher of mathematics in an upper secondary school in Copenhagen and, as Chair of the Danish Mathematics Teachers Association, took part in developing a new mathematics curriculum for the Danish Upper Secondary School.)

In 1986 the Danish Government carried out a survey of the amount and type of computers and computer software in Danish Upper Secondary Schools (pupils aged 16-19). All the schools surveyed (90% of the 155 upper secondary schools in Denmark) had computers. They are usually housed in a central room and are not specifically allocated to mathematics. In about 50% of the institutions the computers are connected in a network that allows them to share a hard-disk and a printer.

The prevailing programming languages are COMAL 80, POLY-PASCAL and BASIC. (COMAL 80 is a language using Pascal-like structures to provide a more powerful programming environment than BASIC.) Most schools have access to more than one language and in 97% of the schools, COMAL 80 is accessible.

In 1988 there are on average 15 computers per school. that is about one per 35 to 40 pupils.

During the last four years, the cross-curricular use of computers and some work with computer-related topics have been compulsory in Denmark in all subjects, for a total of at least 100 lessons over three years.

In the last two years about half the pupils who finished Upper Secondary Education followed a draft for a new curriculum in mathematics created at the initiative of the Danish Mathematics Teachers Association and the Ministry of Education, including some compulsory use of computers. In August 1988 all pupils beginning Upper Secondary Education will be taught according to the new curriculum. Topics recommended for the use of computers include:

- Numerical solution of equations (Newton-Raphson, bisection)
- Curve sketching, graphical work
- Simulation, modelling.

The computers are intended for use in teaching and learning as well as performing calculations. There is not a great deal of software available. Most schools have spreadsheets and some kind of curve-sketching software, together with some specific programs to model economic or biological processes using a mathematical model. In May 1988 about 70% of schools have bought one or two software packages, similar to David Tall's "Graphic Calculus".

Most teachers have had short in-service training courses in the use of computers, but many lack confidence when using them in class. Each school has a teacher in charge of looking after computers and helping colleagues to use them.

Hungary **Turul Török**

In Hungary elementary school is compulsory in the age range 6 to 14, followed by secondary (middle) school from 14 to 18. Classes are often very overcrowded with 35-40 children, and teachers teach 20 to 40 lessons a week. In recent times there have been many changes and reforms in education, with only a few positive results. Children up to fourteen years old rarely know any English (or German etc.). About 40% learn English (in the middle school) but only 5 or 10% can understand a computer text of which few are translated into Hungarian.

In Hungary for the last 6 to 8 years there has been a school course available involving about 50 lessons on computer techniques. It is very popular with the pupils, but not with teachers. No other subject takes computers into account. It is not too extreme to state that the use of computers in the classroom depends on local factors and chance.

Since 1982-3 the Hungarian Government has invested heavily in computer education. Each secondary (middle) school has been supplied with 1 to 3 TRS80 Model II compatible computers and several schools have about two dozen computers (TRS-80, Commodore 64, C+4, ZX Spectrum, Enterprise etc, without any predominant type). The total number of personal computers in education is over 10,000 of which about 100 are currently IBM compatibles.

Methods of teaching, different types of courses, and general ideas as to how computers might be used have not developed to the same extent. Between 100 and 300 teachers are estimated to have been trained professionally for computing (about 3-7% of mathematics teachers), and a further 500 to 1000 teachers have had some self-instruction. The official decision is not to create computer studies as a new subject and no reform is planned in mathematics in the near future.

A survey of 12 schools (10 secondary (14-18 years) and 2 elementary (6-14 years)) - selected from amongst those most likely to use computers - revealed the following information. The number of computers is between 5 and 24, with mean 13.6. Three to six different kinds of computer are used; a room with 6 to 10 of the same kind of machine is rare. Each school has a special room for the computers, with 12-20 chairs, but only two schools have permanent arrangements for demonstrations. Three of the schools have a network and in total there are probably less than 50 networks in Hungarian public education (less than 5% of the secondary schools). Most computers have only cassette storage, though 8 of the 12 schools surveyed have disk drives (usually only one), which is well above average. It is not a simple matter to move the machines to other rooms. The number of monitors is less than the number of computers, with colour display being rare.

In the 12 schools the mean number of teachers interested in using the computer is 2.4 (usually mathematicians). Neglecting the school with the most teachers (8), the average decreases to 1.9. Those surveyed reported the following time distribution in using the computer:

Teaching BASIC	12	15	20	11	20	10	18	8	15	20	12	16
Drill Mathematics								2		6	2	20
Demonstration	1	1	2	4			2	2	2	2	4	4
Informatics							16					

Lack of software makes it impossible to improve these results. Centrally distributed programs are not popular; some teachers develop materials for themselves (and for friends). Eight surveyed schools have bought software, but only two use it! The most effective current use seems to be when advanced pupils are told to write programs for

both demonstration and drill. The lack of disk drives causes the inability to support the teaching of spreadsheets, databases, word-processing, etc. Hardly any teacher knows any computer language other than BASIC and no suitable compilers are available for other languages.

In the 12 years of schooling (6-18) there are about 50 to 70 hours "to see the computer and hear about it". In not too extreme cases there are no practical obstacles to decrease this to about 5-15 hours.

When asked about their main problems, teachers responded as follows:

lack of time and training	81%
lack of methodology and books	9%
lack of software	7%
lack of computers	3%

They are very pessimistic both of the use and teaching about computers. One ray of hope is that in the second year of an experimental curriculum they worked more effectively and with more pleasure than the previous year.

Republic of China **Sou-Yung Chiu**

The computer industry in the Republic of China has developed considerably in recent years, causing a large increase in computer resourses in education. However, these resources are not evenly spread.

In elementary schools the provision of computers has not yet received government approval except for schools for gifted children, which may have an increased budget to purchase machines, and schools designated to test computer-aided-instruction software produced jointly by the Ministry of Education and the National Science Council. Other elementary schools rely on the school administrator being convinced that computers are a useful resource.

In junior secondary schools a small provision is made for computers, but this is limited to an introductory course taught by art teachers (who are unlikely to have a mathematics certificate) and for a course in practical mathematics designed for students not aiming for further education. The art teachers work from a book covering "knowledge" and "operation" of computers. "Knowledge" is covered in two chapters on the information industry including the historical development and its use in daily life and one chapter on fundamental principles of computing; "operation" is "simple programming" in BASIC. The "practical mathematics" taught to the less able pupils uses the computer as a black box for carrying out specific operations such as calculating the average, solving linear

equations in two unknowns or computing the square root. This uses software with chinese characters, although the symbols on the keyboard are the usual Western alphabet.

Most senior secondary schools satisfy a government requirement to provide computer facilities, including a computer room with 25 to 30 computers (with disc drives, and a printer for every five or six machines). The Minstry of Education have issued curriculum standards for students to take an optional course on "Introduction to the Computer". This does not have equal status with the traditional courses such as mathematics, language or science, and is not always taken seriously. Students do not have the opportunity to have "hands-on" experience other than in this course, which usually means at most two hours interaction time per student in the first year and none in the second or third year. Computers are not used in mathematics, science or any other courses.

In both junior and senior secondary most students are channelled into the preparation of competitive entrance examinations for the next level of education. School administrators and parents often consider computers not as tools or resources for scientific enquiry but as electronic games machines which students are advised against using or, at best, postponing use until later years. Mathematics teachers with extra training in computers comment on the situation as one of helplessness.

General Information from the participants in the session

Twenty seven filled in a brief questionnaire, of whom eight were from the USA, four from the United Kingdom, three from the Netherlands, two from France, two from Spain, and one each from Israel, Switzerland, Japan, Hungary, W. Germany, Belgium, Denmark and Greece. In the main these were from the USA, Japan, or Western Europe, where computer provision might be expected to be more advanced than other countries.

Of those responding, none were primary teachers, four taught in the 11-16 age range, 7 in the 16-19 age range, 16 taught in universities or colleges, with 11 being involved training teachers and one administrator (including several individuals in more than one category). Of the twenty two who actually taught mathematics, seven used the computer nearly every day, 8 used it about once a week, 4 less than once a week, 2 less than once a month and one never.

On a scale 0=never, 1=very rarely, 2=most weeks, 3=often, 4=very often, the computer was used by the fifteen in higher education and the seven in schools as follows:

	Higher Education	Schools
Teacher demonstration	2.6	1.0
Pupil Problem-Solving	2.1	0.4
Pupil programming	2.2	0.5
Pupil Drill & Practice	2.2	0.1
Spreadsheets	1.2	0.1
Other (e.g. databases)	0.2	0

Thus of those present in the session, in higher education the computer was used most weeks, or more often for a number of purposes, but in school it was used rarely, or never. For programming, seventeen mentioned the use of BASIC, fourteen mentioned Logo, ten Pascal, two Prolog, and five mentioned other languages, including APL, COMAL and LSL (the two latter languages being Pascal-like interpreted languages for education).

Thus it can be seen that, although the computer is being used increasingly in higher education, it is taking more time to filter into the classroom.

Discussion

Katherine Verrios (Athens, Greece), reported that parental pressure had caused computer to be introduced in Greek schools and that since 1983 the Greek Mathematical Society has conducted teacher training activities in cooperation with the Minstry of Education. Currently about 150 public schools have computers, used mainly for an introductory course with 2 or 3 pupils sharing a computer at a time. Private schools have their own curricula, so are at liberty to use computers more freely.

Dick Lesh (U.S.A.) reported the progress of the WICAT project in the U.S.A. involving 700,000 pupils in 400 schools. Computer aided instruction is here designed to improve test-scores in the current curriculum and has proved to be extremely successful. Unlike other experiences, where there needs to be discussion on what to leave out of the curriculum to make way for other items, here it has been found that pupils cover traditional material at a greater speed; the time saved is used to introduce more “real-world” problem-solving in which mathematics is used as a tool.

Ed Dickey contrasted this with a 1987 survey in the U.S.A. where 70% of teachers reported having access to a computer, of whom nearly half did not use the computer in their mathematics teaching. This proportion was fairly general for rural, urban, and suburban schools. The major use of computers was in drill and practice and in programming. Of the teachers using computers only 8% reported having formal training.

In East Germany the use of computers is not yet compulsory, but plans are being made to introduce the compulsory use of computers into school. In India there is as yet little use of computers amongst mathematics teachers, although there is more use of computers for teaching BASIC. In the Netherlands it was reported that teachers choose only what they feel comfortable with to make their work easier. They avoid more demanding software and are faced with the current technical problem of covering a curriculum which was designed before computers were introduced. In Spain there is a lack of available software - teachers are provided with some software for use in certain parts of the curriculum.

The discussion ranged over a wide variety of subjects, with the prevailing impression of the current difficulties of teachers in typical classrooms as they attempted to come to terms with computer technology. There is no real surprise in this, for computer technology is developing much faster than it is possible to provide hardware and to develop software and curriculum materials for education.

Certain common factors were noted that might be prejudicial for the use of computers in mathematics education. One was the tendency to have general networks of computers in many schools, with very few computers provided for incidental use in mathematics classrooms, thus preventing their integration into the curriculum. A second was the difference between those countries where the use of the computer was compulsory for specified curriculum activities and those where it was optionally attatched to an existing curriculum examined by traditional means. In many countries there are visionary enthusiasts working hard to use the computer imaginatively, but in reality the typical mathematics classroom uses a computer only rarely and teachers will require far more experience to integrate it successfully into their work.