Dr Richard B. Otte, Research Associate, US Office of Education, Washington

A group at MITRE, a firm originally set up by a number of M.I.T. researchers, has developed a prototype data configuration consisting of terminals with among other things an ordinary TV receiver. Commercial cable TV is used to convey signals to the receiver units. A video tape recorder serves as a module selector between the TV set and the cable connection. The terminal is also equipped with a response device and a typewriter.

The memory unit is so limited that it can only retain two frames at a time. The system makes use of reserve channels for commercial cable TV, which helps to bring down costs.

This prototype is now undergoing evaluation. The computer equipment costs are probably the lowest in the country. The purchase price of this unit for 128 users (terminals) will be in the region of 400 dollars p.a. (the overheads are spread out over a period of 8 years). To this must be added running and maintenance costs together with software costs. This computer equipment raises completely new possibilities for the development and realization of CAI instruction.

The Texas experiment

A project has just started in Waco, Texas, for the use of "semi-intelligent terminals on a nation-wide basis to look into a national educational computer utility". The project is being led by the Western Institute for Science and Technology, Waco, Texas.

The computer system is based on a large central computer to which terminals can be connected for batch processing. This means that the system can be used by pupils for various educational purposes and by schools for administrative activities.

The first phase of the project entails connecting schools in different parts of the country. The terminals are of the "semi-intelligent batch type", i.e. in addition to a large central computer there is a mini-computer, a writer, a card reader, a CRT screen and some kind of in-feeding member.

The mini-computer is of size PDP-8 .The aim of the mini-computer is to make it possible for certain computer activities to be conducted at local level and at the same time provide in-feed and out-feed/input and output members for a large central computer in Texas.

Question: By what stages is the experiment proceeding?

Otte: First we are connecting up 5 remote terminals. After two years we will probably have 30-40 terminals working, after three years 60 or more. The local school, college or university pays for its share of the equipment. By the end of the third year we hope that the experiment will be paying for itself as far as the equipment is concerned, in which case we will discontinue Federal aid.

Question: What particular questions do you hope this project will supply the anwers to?

Otte: First and foremost the question: is it economically feasible at the present stage to set up a computer network covering the entire country? We hope to find out what problems arise when data networks cross state boundaries, something which can lead to political problems as well as problems of distance. We also hope to find out to what extent a system of this kind can support both administrative and purely educational aims. We expect that a comprehensive data system will prove cheaper than a system in which every school has its own computer.

Dr Ward Mason, US Office of Education, Washington

Dr Mason is in charge of "Regional Labs" and "Research and Development Centers", both of which are concerned with research and development work. There are 25 such institutions altogether in different parts of the USA.

There are a number of programmes involving computers:

1 Southwest Regional Laboratory in Los Angeles is conducting a CMI experiment in which efforts are also being made to employ the computer as a research instrument.

2 The Learning Research and Development Center in Pittsburgh, Dr Robert Glaser, is engaged in research on CMI and CAI.

3 Research on better schools is the title of a partially computer-based experiment in progress at Philadelphia.

4 The Northwest Regional Laboratory in Portland, Oregon is developing the so-called REACT programme for the application of computer technology.

5 The Regional Lab in North Carolina is working on the application of computers to administrative tasks.

6 The Wiche Project (WICHE: Western Interstate Commission for Higher Education), which has now been in progress for several years, is aimed at the development of a "standard data system for colleges and universities to use for management purposes", in other words a computer-managed management information system.

Professor Wilbert A. Pinkerton, Jr., Harvard University, Graduate School of Business Administration, Boston

Pinkerton has tried to use the computer for management games of various kinds and as a means of achieving interactive learning.

Pinkerton:

The computer is a necessary aid in management games in teaching. This need not entail the realistic reproduction or simulation of a particular activity. It can be enough to programme the decision data needed by the different teams (who compete against each other) for each new move confronting them. Computer-based simulation models can also be used to give students an insight into the situations which can confront a manager. At the same time the student can learn how to utilize computer-based simulation so as to obtain more reliable results.

The students find this form of teaching extremely useful and efficient. Two hours after they have made a particular decision, e.g. on a question of marketing affecting sales during the third quarter of the year, the results are in their hands and they can go on, four or five hours later, to consider decisions concerning the fourth quarter.

Game programmes of this kind can now be bought at moderate prices, for 12 dollars one can get a manual, student material and the programme (on tape).

Dr Zenon S. Zannetos, Massachusetts Institute of Technology (M.I.T.), Boston

Zannetos:

I have been working on programmed instruction for many years. I soon became convinced that programmed material should not be "offered" via a teaching machine but should instead be presented in the form of a programmed text. Programmed text is cheaper to reproduce in book or booklet form and it takes less time (no waiting time).

For a long time people thought that computers should be used in the same way as teaching machines in programmed instruction. This is feasible but it is an expensive procedure. There are undoubtedly more sophisticated applications available for the computer as a teaching aid.

In my opinion, the sector where the computer really comes into its own is concept learning and the study of relations between concepts (conceptual structure). The experiments we are conducting and which we have been working on for three years are called the Associative Learning Project. For instance a student should be able, via the computer, to asks What is the relation between concept A and concept B? Via the computer the student can obtain definitions, be given an opportunity to structuralize relations and obtain an answer to his questions. The experiment is primarily related to accounting (book-keeping) studies.

This argument presupposes that information is not just data but a combination of contextual association in data context. In fact we cannot deduce information from data unless the data are placed in the right associative context. It follows that a student would learn more if we could show him how data are used in a context.

To begin with we tried to offer the material to students in the form of programmed teaching material (text). Next we tested CAI material of a normal type. Finally we arrived at the idea of using a combination of methods making better allowance for the complexity of the subject matter and the desires and knowledge of the students.

In the experiments we are running at M.I.T. we first let the pupil work through a computer-based programme which is designed in such a way that each individual step offers him a choice of routes to the next step. For instance, he can ask a question connected with one of the steps he has already passed. The computer will then take him back, say, to a certain definition and structuralize certain relations. In this way we hope that the student, starting on the basis of his own limited knowledge,

words, PLAN is more flexible and, consequently, has a bigger guidance component than IPI.

In many respects. however, IPI and PLAN resemble each other.

Question: Is there any different between the testing methods of the two systems?

Shanner: The students are not given any numerical scores in PLAN. All the test does is to show which objective a student has attained or failed to attain. For instance, he may pass three of five tests and then be taken back to material enabling him to pass the two he failed. The IPI student is tested on what he has studied. The object of the test in PLAN is to show what the student can do after he has studied a particular section.

Question: Is there a future for the CMI idea in schools?

Shanner: American schools have never taken efficiency seriously and have never desired to work for it. The percentage of time per day devoted by students to active learning is very low, perhaps as low as 10 per cent. Of course, we cannot expect students to be 100 per cent learning-efficient six hours a day, but CMI can probably raise their efficiency.

There are a host of problems in school that we have not solved. It is not necessarily aptitude but time and practice that correlate most with performance. The time and practice devoted to a subject seem to correlate with performance achievement as much as anything else.

The theory behind the PLAN project is that if learning tasks can be redistributed as regards both teacher and student in the course of a six-hour school day, we can expect the percentage of time in which each student is engaged in active learning to rise from 10 to 15 per cent without any changes being made to the ordinary teaching material. In this way one could achieve

At one school we have full periods and that of course is easy to plan a timetable for. But difficulties still arise, due partly to the teachers working in teams and partly again to subjects being scheduled in blocks. Difficulties also crop up as a result of students changing their minds at the last minute.

We assumed that we would have to programme a manual timetable and so far we have based everything on logarithms. Computerized timetable construction generally is something of a trial and error business. There is no direct mathematical solution to the problem.

But we are working on the matter and we are very interested.

Question: What is your view of the idea of a total information system?

Duerstock: In practice there is hardly any total information system in existence. A total information system would mean a system in which there are links between different registers and in which a student can be retained in one register even if he is not eligible for others. A total information system is extremely hard to construct because you do not know what relations apply between different registers and different departments. The fees which have to be paid by the student may come under the finance section but at the same time they are part of the business of registration. The same particulars have to be made available in several different places, which makes things extraordinarily complicated. This means that you have to define all relations between the different tasks and registers before you can even think about doing anything else.

Purely theoretically speaking, you can construct a system of this kind, but when you then try to put it into operation

better student performance all down the line. The novelty in PLAN is that we have introduced a kind of management instructional system. But we have not made any alterations to the normal presentation of the teaching material. Nor have we made any alterations to text or audiovisual elements.

The problem of course is to analyse the activities which go on in the classroom. This means that we have to find out what things are of an instructional nature and which are of a non-instructional nature. In an ordinary classroom situation, 90-95 per cent of the communication comes from the teacher. In a situation where individualizing material occurs, 70-80 per cent of the communication comes from the students. Two-thirds of the communication in a group is of a noninstructional character, for instance, "get out your pencils", "open your books" and so on. There is nothing intrinsically surprising about this. A lot of instructions are needed to get 30 students started on something. In the PLAN project the instructions are given to the student in writing and consequently do not take up anything like the amount of time they require in ordinary teaching(in PLAN two-thirds of the material is of instructional character and only one-third of non-instructional character). The strategy of conventional teaching seems to be for the reacher to let the subject matter pass through the student, while in individualized instruction of the PLAN type you try to do the opposite, i.e. take the student through the material.

Question: Are any new CMI projects going to be started in the USA?

Shanner: Certainly. Of course, PLAN does not solve all the problems in the CMI sector, rather it is to be seen as a prototype. One problem is that we have to develp learning situations which are less dependent on printed material.

The PLAN project includes obtaining details from the computer as to what the students can do and what the teacher should do. We can then read off exactly what students have done during a given time, what results they have achieved and so on. This means that the teacher need not go to the trouble of collecting that information. It is already available via the computer terminal. The teacher does not need to have a registration system of his own.

Another important experience we have gained is that the students learn a great deal from each other. Some students can even perform teaching tasks in the classroom. Students may perhaps be more efficient at reaching their classmates than the teacher is. A student who is having difficulty with a particular item, say item 4, can look at a list showing which students have done this item and he can then ask one of them. He should not contact the teacher unless the student in question is unable to help him.

Dr. Dexter Fletcher, Stanford University, Palo Alto

Dr. Fletcher is Research Associate at the University, which means that he has practically completed his doctoral thesis. He has mostly been occupied with the development of CAI material in language arts. He has been involved in the CAI project since 1965.

Fletcher:

Our CAI project can be said to comprise two phases. In phase 1 we had an IBM 1500, which was very expensive and cost 2 000 dollars per year and student, an amount which could be justified to a certain extent on the grounds that research was being conducted in connection with the experiment. It was not a suitable computer for computer-assisted instruction. This first phase comprised an initial reading course and mathematics courses from grade 1 to grade 6. The computer equipment also includes a CRT screen and a light pen and a slide projector (random access). Thus our data system was a very well-developed one and we believed in the idea that the better the equipment the better the instruction. In the experiment the computer took charge of most of the teacher's functions.

The experiment taught us an expensive lesson and we realized that we could not go on this way. In the next phase, therefore, we endeavoured to make the experiment as simple and inexpensive as possible. It was at this stage that we started using teletype only. We have also given up the idea of putting all or virtually all the subject matter into the computer. We have learned that only certain parts of the subject matter are suitable for computerization. It seems reasonable to programme the parts you know you can give a good presentation of. This means that you have to analyse the course and select the parts that are suitable for computerized learning.

The computer with CRT screen is superior to the teletype equipment. This is particularly true in the case of language teaching. A text can be presented more quickly with CRT and if you are going to learn a foreign language via computer, some form of sound equipment is needed. Access to a cheap CRT screen and sound equipment controlled via a computer would open the way to big developments in this sector.

But one can also conduct many interesting experiments with teletype equipment. After all, we know so little about teaching and learning. But there are a lot of questions concerning e.g. the problems of how long the "steps" should be, how much time the student should spend at the computer, problems surrounding question and answer techniques and many other things requiring a great deal of methodological development which is not intrinsically dependent on advanced equipment. We will have to

do more research into these matters. The really interesting thing is to establish a dialogue between student and computer or between student and programme, something which Suppes in particular is interested in developing. My attitude is that we still do not know enough about natural language to be able to create a truly meaningful dialogue system for CAI.

Question:

One item of criticism that has been voiced in many parts of the USA is that you hardly need such complicated apparatus as a computer to transmit the subject matter which is being transmitted by computer in present CAI programmes. A simpler teaching machine costing just a few hundred kronor is quite enough. How do you feel about this?

Fletcher:

One has to remember that we are only at the beginning of what will probably be a long process of development. People did not talk about cost/effectiveness when motor cars came in either, and it is a mistake to talk in terms of cost/effectiveness at the beginning of a long development process. The discussion which has occurred as to whether one should keep to "cognitive" subjects is a practically impossible one because nobody can describe what a cognitive subject is or what parts of a subject are cognitive.

Question:

Have you carried out any experiments in other subjects besides reading, mathematics and language arts?

Fletcher:

Yes, we have penetrated a wide range of subjects, but perhaps the most important thing is that we have built up a techniques for CAI which can be applied to any subject.

Question:

The CAI programme is frequently criticised on the grounds that it is not properly integrated with teaching generally, that is with the teacher's actions and with other aids.

Fletcher:

Yes, there is certainly something in that. But we are trying to computer-base those parts of the subject which fit in with the teaching process.

Dr Bruce Harlow, Director, Stanford School of Education for Research and Development in Teaching, Palo Alto

Mr Harlow began by going over an organizational chart of the institution and gave an account of three separate "programmes" or problem sectors at the centre of its research and development work:

1 Heuristic teaching
2 Environment for teaching
3 Teaching students from low-income areas.

The object of the first of these programmes is to create a model programme designed to create teaching which will make the pupils interested in arriving at their own answers to certain questions (the word heuristic comes from the Great "Eureka" - I have found it). An investigation is also being made of what things can be done by the human teacher which the computer either cannot do at all or cannot do as well. Programme 1 has also included the collection of data on teacher behaviour and measures taken by the teacher in the teaching context. Work has been in progress for many years on the compilation of a comprehensive data bank for the project.

The second programme is concerned with the surroundings in which teaching can be conducted. Micro-teaching is being considered, as are the different personnel categories assisting the teacher. The third programme is devoted to research into the teaching of students from low-income areas. In this sector Dr R D Hess has written a thesis on the computer as a socializing agent.

Hess' survey covered children of Hispano-Mexican origin at Junior High School. The computer-based courses are in mathematics. Attitudes to the computer as a source of information are compared with attitudes to the human teacher. Generally speaking these children showed a more positive attitude to the computer as a source of information than to their teacher.

Dr. Francis Sobol, Florida International University, has constructed a classification system for what can be required of a teacher. He has endeavoured to computer-base this taxonomy. A technical report will be available in a few months.

Dr. David Aaronson, Systems Development Corporation (SDC), Santa Monica

Dr. Aaronson works at the Corporations's CAI centre and is responsible for the PLANIT project, i.e. the development of a programming language for interactive instruction specially designed for CAI.

The programme language is designed in such a way that it can be transmitted to different kinds of computers. The purpose of PLANIT is to evolve a programming language which will be suitable for computer-assisted instruction regardless of language, level and computer. The language is constructed to resemble natural language and it can also be translated e.g. into foreign languages without any difficulty. The idea of PLANIT is for the teacher wishing to make a CAI programme to be able to use the language after only one day's training. A teacher wishing to use the computer for CAI should not have to penetrate two different subjects, i.e. learn to arrange a CAI programme and also learn a programming language. Efforts are being made to build on natural language to the greatest possible extent. To obtain a

lesson via the computer one writes "get", to execute one writes "ex", to save a lesson or part of a lesson one writes "save" and to insert something in the computer one simply writes "i".

Dr. S. Coulson, Systems Development Corp. (SDC), Santa Monica

Coulson feels that CMI (Computer Managed Instruction) ought really to be termed CAIM (Computer Assisted Instruction Management). The Term "computer-managed instruction" gives one the impression that the computer makes all the decisions about what is to be taught. As Coulson sees it, decisions still remain the teacher's responsibility. The main difference between ordinary teaching and CAIM is that the teacher receives feedback and prescriptive information about what should be done in order for the student to attain different learning goals.

Thus the purpose of CAIM is:

to give the teacher an opportunity of adjusting his teaching to the student's rate of progress,

to indicate sub-skills in which the student needs auxiliary instruction,

to indicate what prescriptive instruction or auxiliary instruction the student is in need of.

SDC developed a CMI system called "Instructional Managenent Systems" (IMS) in reading and mathematics, grade 1, for Southwest Regional Labs(SWRL). The system was run for 2½ years in a number of schools in Los Angeles (solely for a preliminary trial). SWRL then took over. The students are given AA equipment (earphones/ microphone and group tape recorder) and pre-recorded tapes telling them how to work through the material. Stimulus material is provided in the form of printed sheets. The students have to match picture and words and supply an answer. Their answers are corrected by an optical reader. The system incorporates group tests, group reports and reports on each student. The computer is used batch-mode, which saves time and money. CAIM is far cheaper than CAI, probably costing no more than 1/5 as much. CAIM gives the teacher rapid test results together with other feedback from the students' activities. By contrast, most CAI systems are unable to provide good diagnostic summaries of the students' performance throughout the course.

Question: Some critics have said that the individual data, i.e. the data concerning the student's background, environment and achievements included in the majority of CMI systems are too limited for CMI to be a feasible proposition. How do you feel about this?

Coulson: Yes, of course we need more information. But at the same time one can ask: Do we know so much about learning that we can make use of the individual data available? Personally I do not think we do.

Question: What kind of individual data do you think are of value in making a CMI system work in the teaching context?

Coulson: The data we have in our IMS system are enough. We do not know what further decisions we require the help of the computer with. Certain systems have been made to include different kinds of personal data: interests, attitudes and so on. But I have not seen any system that has been able to utilize this information in a meaningful way.

Question: Can CMI be used for all subjects or is it best suited to certain subjects, base subjects, perhaps?

Coulson: No, I think CMI can be used in all sucjects. Like CAI and programmed instruction, CMI presupposes that one can obtain concrete behavioural oojectives. For instance, CMI can hardly mean anything in literature and music appreciation, where it is difficult to measure the progress made by the student. CMI, then, is dependent on our ability to measure objectively the students's progress, and this requires clear, concrete learning objectives.

Question: How have you solved the problem of updating?

Coulson: That is our heaviest item of expenditure, a heavier item than the cost of using the computer. But methodologically speaking it is not a very difficult problem.

Question: What is happening in the CMI sector: Are many new CMI projects being started?

Coulson: No. Here as with CAI, there is a shortage of research funds. But a new CMI project in reading involving about 15 000 children was started in Los Angeles. In purely commercial terms CMI has not been a very great success, and the same applies to PLAN. But I believe that CMI will break through one day.

Question: What do the teachers think of CMI?

Coulson: A survey we carried out indicated that the general attitude was positive. But a great deal depends on practical things. The work input on the teacher's part is very important. Our project meant less work for the teacher in connection with cataloguing, auxiliary material and so on, and this was appreciated. On the other hand they showed a negative reaction to a couple of extra forms which they had to complete every week.

Question: What do you consider to be the difference between your system (IMS) and Robert Glaser's IPI?

and instructions as well as providing a diagnosis of the student on the bases of a battery of tests. PLAN costs 100 dollars per student p.a. whereas IMS costs 1 dollar per student p.a. PLAN is tailored to a particular data system while IMS can be used in various data configurations.

Question: Do you believe in the computer as a test instrument, i.e. can computers be made to perform more advanced tasks than correcting multiple choice tests and working out tests scores?

Coulson: Allen Page has done a study in which he has tried to show different development possibilities. He contends that we do not need to use such sophisticated tests as we imagine. Often teachers do not use a particularly advanced system for marking précis-writing or essays. Allen Page programmed a computer for marking essays. He went by the number of words, syllables and unusual words used on average. By using 5-6 simple criteria of this kind he attained a high correlation, about 80 per cent, with manual marking. But it would require an enormous data capacity to take into account all the syntactical problems involved by language.

Dr. Richard Schutz, Southwest Regional Laboratory for Educational Research and Development (SWRL), Santa Monica

SWRL have developed a CMI project which is mainly concerned with reading. This system, known as IMS (Instructional Management System), can however be adapted to any subject. It is a type of planning model for a subject. The model has been made to include a preliminary test and a host of diagnostic tests.

A meticulous goal description has been compiled for IMS. A distinction is made between general and specific learning objectives. As a rule, general objectives consist of a group of specific objectives covering a prolonged period (several months or a whole term). Matching figures which are identical as regards size, shape or content is a typical specific learning objective which is included in the general objective "visual matching".

Applications of the computer in schools/the educational sector

Many attempts have been made in the U.S.A. to classify the sectors of application of the computer. No commonly accepted classification exists at present. The following division is based above all on the tasks occurring within the educational sector.

1. The computer in administration and information

1.1 school administration:

salary routines, pupil and teacher registration, merit and absence registration, timetable construction etc.

1.2 information and documentation systems

2. The computer in teaching

2.1 computer-supported instruction

2.1.1 the computer as a calculator - computer-aided simulation

2.1.2 as an educational aid and control member (CMI, tests, syllabus instructions, study and vocational guidance information).

The computer is used to provide teachers and pupils with instant information (feedback) concerning the pupil's achievement in a particular test or the way in which the pupil has completed previous tests. The computer registers data concerning the pupil and his achievement as well as

Tests administered once or twice every week enable the teacher to follow the student's work in detail. The tests are marked via computer. The teacher obtains the test results immediately. These results also include the average score of the group on each general objective. The computer supplies the teacher with information on the students' performance in each test (both general and specific). He also obtains each student's test profile together with information of the student's performance in previous tests. Study recommendations are also given via the computer for each student. It is then up to the teacher to decide whether to follow these recommendations or modify them. More detailed instructions regarding auxiliary tasks for the student are not computer-based, however. A code-number via the computer gives the teacher the orientation he needs.

According to Schutz, IMS is an inexpensive CMI system. The cost per student p.a. is 1 dollar as against 100 dollars in the case of the PLAN project.

In order to keep track of the student's achievement in a CMI system it is an advantage to have access to microfilm, microfiche and some form of hard copy.

Mr. T.S. Hancock and Mr. D. Dooley, Education Service Center, Houston, Texas

Houston is the largest of 20 regional data centres in Texas. These centres were started in 1967, when a plan was drawn up for data services to schools in the state. The Houston centre serves about 600 schools numbering over 500 000 students.

The data centre has three main functions:

1 to supply computers for the teaching process in classrooms (e.g. for problem solution, drill and practice)

2 to provide data support above all for vocational data processing classes

3 to perform data services of various kinds (e.g. salary computations, timetable construction, diagnosis).

The school districts enjoy a great deal of independence within this computer system thanks to the so-called RJE terminals (see B in the enclosed figure illustrating the hardware in the system). The districts are connected to the two large computers but can nonetheless act independently, among other things, in

a) using the terminals as satellite computers quite independently of the central computers for running their own programmes

b) using the large computers at the centre to process their own data

c) using their own programmes for processing in a large computer

d) using the satellite terminals locally for teaching purposes.

On the other hand there are no standardized and common data for all the school districts in the system. There are a number of standardized national tests, but the school districts are at perfect liberty to use whichever tests they like, so that the test results are not included as a common component in the data base. Grades are not uniform either: certain parts of the state use a combination of letters of the alphabet while others make use of a combination of figures and others again use a combination of both letters and figures.

Computer-based teaching material registration exists, among other things in the form of a register of teaching materials for remedial instruction among handicapped children. Thus lists of teaching materials can be printed as required, but ordering routines have not been automated, although good progress has been made in this direction.

The centre is also building up a "Job-occupation" data bank, the aim being to create a register which can be used via the remote terminals. In this way students and vocational counsellors will be able to ask for facts from the register which will then be forwarded to those asking for them.

The table below reflects the scale of the data services offered by the centre.

REGION IV COMPUTER SERVICES PARTICIPATION 1970-71

	Student Master file	Student Class Scheduling	Grade Reporting	Attendance Accounting	Test Scoring	Instructional Time-Sharing (CAI)	Vocational Remote Job Entry	Payroll
Districts	29	26	20	23	33	22	10	24
Campuses	232	77	115	182	464	86	10	
Students Served	184,508	89,810	105,082	147,656	323,477 (Tests Scored)	37,500	700	25,000 (Checks Printed Per Mo)

The local school districts are calling for increased computer automation for planning and administration purposes and also to give them access to sophisticated aids in the teaching process.

A management information system is needed for long-term planning. By the end of this year experimental activities will have started using an integrated file handling system in which the school districts will have access to the registers kept on a decentralized basis at certain terminals. CRT and other forms of visual reproduction will be used. It is realized that a great deal of training will be needed to get the system implemented in the school districts. There are no finished programmes, instead all the different pieces in the system have to be tailored to their purpose.

Dr. Paul Merril, Florida State University, Tallahassee

In Dr. Merril's opinion the following areas of application can be distinguished for the computer in the education sector:

1 Data analysis
2 The computer in school administration
3 Resource scheduling
4 CAI
5 CMI
6 Simulation
7 Problem solving, i.e. the computer as a calculator
8 Information and documentation

Resource scheduling implies the use of the computer in distributing and keeping track of the teaching materials, equipment and premises used within a school system and often pooled.

Automated testing can be regarded as a sub-sector of CMI.

Automated testing implies that the computer presents the student with current items, computes his score and "diagnoses" his knowledge on the strength of his answers.

Merril:

We have also tried to automate the so-called SLAS test, which is a one-to-one type of test used by a psychologist together with a student. Usually this is a very expensive testing procedure.

The test requires fairly sophisticated natural language processing and is therefore quite difficult to construct. The questions are open-ended and the student answers in natural laguage. This means that the computer must be able to interpret his knowledge. But these test problems are not unduly complicated by comparison with the problems normally arising in connection with natural languages, because the questions can be kept within a particular answering sector. We have been quite successful on this point and have achieved a high correlation between open-ended question tests via the computer and normal testing procedures (using a one-to-one type of test with a psychologist only). A high correlation has also been achieved with other tests.

Question: How do you solve the input problem in this context?

Meril: Via a computer terminal with a CRT screen. The students write in the information via teletype. The computer is programmed for certain keywords. If the computer does not "understand" it asks for additional information.

Question: What types of student answers can the computer process?

Merril: The computer can easily handle multiple choice questions and answers. It is also easy to programme very short answers (e.g. in mathematics).

As soon as you come on to open-ended tests in which the student has to make a verbal statement comprising 2-3 sentences, things become more difficult. The same thing can be expressed in many different ways and it is hard for the computer to process many different answers and synonyms. If the pupil is to give a

definition of a word, the programme must contain a sufficiently large number of synonyms to cover the definition. One method is to programme in a given number of answers and let the student write a limited number of key words. There may be a certain connection between these key words which the computer is able to sense. If the student uses incorrect key words or gives an incorrect statement of the relations between key words, the computer can supply the appropriate feedback.

Another things we are working on is known as sequence testing. Sequence testing means that the student is given a number of questions focussing on his knowledge within a particular test sector. If the test is concerned with mathematical models, the computer programme will take into account not only the student's previous answers and test score but also the certainty and knowledge he displays. The computer also registers the time it has taken the student to answer. On the basis of preceding answers, test score and the quality of the answer the computer then indicates the test item to be presented to the student in the next step.

The main idea of sequence testing is to offer the student a whole series of test items based on an algorithm and so make it possible to offer the student the minimum number of test items necessary to guarantee a good test result. In the first instance these experiments are aimed at reducing testing times and test work. Quite a lot of this test methodology is now being applied within our CMI projects. Automated testing and sequence testing are extremely costly but at the same time they are to be regarded as rational because they reduce the time which has to be devoted to the actual test. Conventional tests carried out by psychologists cost a great deal. Computer testing should lead to reduced costs per student test.

We have also used the computer in medicine and in certain information-sensitive sectors, e.g. programmes on sexual matters and drugs. Especially on these subjects, many students find it easier to "converse" with a computer than with a human being. For many students the computer seems to provide neutral and objective information. It also seems to be less pregnant of emotion than is often the case with human contacts. Our experience indicates that students would rather consult a computer than their teacher on matters concerning sex and drugs. In a medical examination, to take another example, one could therefore imagine a computer asking the standard questions normally put by a doctor in a particular situation, processing the answers and presenting the results to the doctor when he attends to the patient. But we have only limited experience of this computer sector.

The use of the computer in a sector where the student feels that he can ask delicate questions and obtain more "neutral" treatment than in the normal way is a new and promising field within the CAI sector.

We have also tried using the computer as a research instrument. The computer gives us greater control over the variables included in an experiment. Thus with a computer one can achieve exact control of the material which a student has to learn. The computer can also regulate the speed at which the subject matter is to be presented. One can also check that the student does not go back to consult earlier material (if by any chance one should have occasion to check such things). One can also use the computer to handle experiments including many different kinds of data from treatment and actions. Thus the computer can be used to register data and students' answering times.

Dr Philip Duchatell, Florida State University, Tallahassee

Dr. Duchatell works at the Computer Assisted Instruction Center (CAI-Center), which is a special unit ancillary to the university data centre and exclusively concerned with computerized instruction.

CMI projects

An interesting experiment is in progress in the field of what is termed programmed instruction. The student is given ordinary teaching material (text books, work books etc) which he reads (off-line). At regular intervals he visits this CAI centre, registers and is given a series of questions via the computer, which also supplies answers, thus providing a type of feedback. In this way he can see approximately where he stands and how much he knows. If he makes a mistake he is given either a correction or a comment. The CMI course sometimes covers an entire term. The course is divided into 20 modules. A number of objectives to be attained by the student have been drawn up for each module. In one and the same module the student is confronted with 20 questions. The student can ascertain for himself whether he has attained the predetermined goals. Thus a great deal of the responsibility for learning is entrusted to the student himself. The students do not use open-ended answers, only multiple choice ones. Research is being done into the use of multiple-choice answers, but this is a difficult problem because it is hard to give reasonable clear and unambiguous answers of this kind. The root problem, of course, is that the student understands the computer better than the computer understands the student.

The course has been used for two years. It also includes teaching the student to write a short programme, though this programme is not written for a computer. The data received through the stundent's answers in the CMI programme are collected so that they can be analysed to see how well the student has coped with the items.

The equipment used comprises a PDP-8 acting as a module change-over for a larger computer, an IBM 1800. The mini-computer operates the 8 teletype terminals used by the students for the

CMI programmes. CRT screens operating together with the IBM 1800 are also included. There is also a teleprinter, a card punch and a punch card reader. Finally there is a PDP-9 which acts as a module change-over between the IBM 1800 and the teletype terminals, which can be 240 miles away. The latter equipment is used by students at junior level, where a certain amount of research is in progress. Altogether there are 16 CRT terminals and 15 teletype terminals within this centre. The installation has been in use since about 1965.

Mr. Floyd Howe, Director of Computing Services, Miami Dade Junior College, Miami

Joseph Duerstock, Associate Director of Computing Services, Miami Dade Junior College, Miami

Question: Has the computer been used as a calculator at the University?

Duerstock: For over a year now the institutions of physics and mathematics have been using the computer for this purpose. They have reported highly positive experiences. Both teachers and students work with the computer equipment (IBM 360 and IBM system 3). Sometimes batch processing is practised. One experience that has been reported is that drop-out among the students declines when the computer is introduced into teaching. In one course (accounting) the drop-out rate was about 50 per cent. Since computer-based courses were introduced it has fallen to zero.

Question: What experience do you have of the computer as an aid to school administration?

Duerstock: Broadly speaking the introduction of the computer into school administration is a question of sound planning. A positive attitude to the change-over to a computer-based system is important, i.e. administrators, teacher and others concerned must feel and experience that what they get out of the computer is valuable and important in their work. But they have to experience this if the new system is to be accepted.

From the administrative point of view we are in favour of a student registration system constituting the entire gambit for the introduction of a computer-based information system. Our data system includes the admission of applicants, grade reporting, salary routines, stored inventory, registration of students' test scores and so on.

Question: Have you tried computer-based timetable construction?

Duerstock: We did try it recently, but that was only two months ago. We have carried out two experiments. The first one was only 80 per cent successful while the second, which was very simple, was 99 per cent successful. But we are still uncertain as to whether it can be done.

The greatest difficulty lies in developing a system which will rapidly supply us with the information available. One system which is thought to be quite cheap is Memorex microfilm. We are planning to transfer a great deal of information to microfilm. Something must be done to prevent our libraries bursting at the seams with reports and documents.

Dr. J. Tresher, U.S. Office of Education, Washington

ERIC (Educational Resources Information Center).

Tresher: Something which people tend to forget about ERIC is that, while it began as a pure information system, since 1967 it has constituted an information analysis system, i.e. researchers at our clearing houses read journals, books and so on within a particular sector, synthesize the information, assess it in the light of their experience of the sector and analyse it. A large proportion of the publications issued by ERIC are primarily analytical.

One of our problems, however, lies in obtaining the financial resources for publishing our work. Another is to find the time and money to answer all the inquiries that come in. Last year we nonetheless replied to 60 000 - 70 000 inquiries, but this was still not enough. A third problem: we are constantly meeting people who say that they have never heard of ERIC and that they could have used our services if only they had known of our existence.

Question: Have any updating problems cropped up yet?

Tresher: Yes, we have noticed them. But ERIC is so new that we have not yet had to discard any material. But sooner or later the problem will arise.

Question: How much does ERIC cost altogether?

Tresher: The budget for the entire system is in the region of 4 million dollars annually. Each clearing house (there are 19 at present) costs about 180 000 dollars a year. This does not include certain donations.

Question: What are your plans for the future?

Tresher: We have certain plans (not too articulate as yet) for the establishment of Educational Agents, that is educational experts following the example of the agricultural sector by travelling round to the schools and giving good advice about how to solve certain problems concerning organization, methodology or teaching materials. We are conducting certain experiments at present but we do not know how far we can go. Another problem is that our existing 19 clearing houses are not equal to the task of serving as information centres. Centres of this kind could be established within a school district or a state. They could use the same data base of information as ERIC. At the moment we are studying whether these information centres are to function on a local or regional basis.

We also want to advance further as regards the analysis of information and the evolution of better products. We have realized that we cannot concern ourselves solely with products dealing with research. We also want to reach the practitioner outside, the teacher and the school administrator. Significantly enough, we altered the original name the Educational Research Information Center to the Educational Resources Information Center, a change which reflects the change in our objectives.

Dr. Roger Levian, Rand Corporation, Washington

Dr. Levian has led a project financed by the Carnegie Commission and aimed at investigating the possibility of using computers in higher education. One of the tasks of the project was to structure the sector "the computer in teaching". It was found that a distinction should be made between:

1. the computer as used in administration and documentation
2. the computer as used in teaching
2.1 computer education and the teaching of data techniques
2.2 teaching with the aid of the computer, i.e. the computer as an implement in the teaching process and as a substitute for some other implement, e.g. TV, calculator, book or even teacher.

Levian: The greatest problem in using the computer as an aid to teaching lies in the difficulty of establishing an organization guaranteeing the production of good and adequate teaching programmes for the computer. There is an organization of this kind for printed teaching materials. Where educational software for computers is concerned, there is a complete lack of all the forms of encouragement (royalties, copyright, prizes of different kinds) existing in the field of printed materials. The absence of a sales organization also entails several disadvantages. At present there are many teachers in different parts of the country busy designing data programmes for practically the same sector or item.

Question: How can one get out of an impasse of this kind?

Levian: One way is to go in for a large central computer with time sharing which serves not just one school sector but many, it can perhaps be specialized either regionally or by subjects. A number of different data programmes can be located in this data system. In this way many people can (via terminals) have access to the same material. The development of so-called multiplex techniques will make it possible to establish contacts with other large central computers in various parts of the country. What we need, though, is a publishing house type organization to develop and produce the software, improve and supplement the material and produce supplementary material (material used side by side with computer activities). Every time a student then uses a programme he can be charged a given fee which can also include royalties for the author and remuneration for the publishers.

Question: Does not a system with a large central computer and many terminals mean formidable telecommunications costs?

Levian: If you use multiplex techniques and let 20 teletypes use a voice grade line, the cost is only 1/20 of that involved by one time. There are also other ways of reducing telecommunications costs, e.g. by means of microwave techniques.

Question: CAI has been severely criticized in many quarters in the USA. How do you view the possibilities of developing of the computer?

Levian: I never use the term CAI, for many educationalists it is like a red rag to a bull. Many people see CAI as a way of presenting simple courses with a stereotyped programmed teaching material which only caters for mechanical learning. Do not let us speak about CAI, let us speak instead about different ways of using the computer for teaching purposes. One way is drill and practice, another is tutorial mode. At Potsdam, a state university in New York, the computer has been used to teach students the theory of music. A computer-based course has been constructed which is a mixture of drill and practice and tutorial mode and it works perfectly. Every year 500 students complete the course with great success. It helps the teachers with the difficult problems of individualization. Another example is the Russian course at Stanford, where drill and practice has been combined with a learning studio and text books. Although the computer here is used for fairly simple drill exercises, the course has been shown to produce better results than the parallel course, which uses the same material but does not include computer instruction.

Thus there are a host of sectors of application for the computer in education and these must be analysed to find out where the computer has an important part to play. Probably we overrate man as a lecturer, instructor and teacher. The computer is probably capable of taking over certain tasks and doing them as well as or better than the human teacher.

Question: During our travels in the USA we have encountered many different opinions of CMI. Some educationalists regard CMI as the most promising sector for the computer. How do you feel about CMI and its possibilities?

Levian: As far as higher education is concerned there is every reason to believe in CMI as an important sector of use. It is probably in higher education that efforts should now be made to use the computer. Compared with basic education the costs (per student) are far higher, which makes it easier to argue in favour of teaching with the aid of computers. Another thing is that students at higher levels are better able to utilize the interaction which the computer affords.

Mr. Thomas Byrne, Kiewit Computation Center, Dartmouth College, Hanover

Byrne

In 1964, when we began to make use of the computer, we were convinced that it was important for all students - and not just students of the natural sciences and technology - to be able to control and programme the data power. This philosophy posed two problems: how were we to introduce the computer for 3 500 students and how were we to create the financial resources needed to do so?

We soon realized that batch processing could not be used because this would mean 3 500 students queuing up in front of the computer with all the small jobs one could expect them to come along with. A better way of tackling the problem was to use a so-called time sharing system. The first time sharing system in the whole of the USA was created here in 1964. The development of good software was just as important as obtaining good hardware. This was done by creating a programming language, a simple language called BASIC which is now used everywhere in the USA and in other parts of the world.

To induce the students to use the computer we made problem solving obligatory for all newly enrolled students. Within four years 80 per cent of the students were using the computer in various connections. But one also has to convince the members of the faculty. Indirectly they became interested when they saw their students solving more problems in a better way and in a shorter space of time than usual. The teachers themselves began using the computer in their teaching, among other things for CAI-oriented tasks. For instance, geography students were made to learn cartographical symbols with the aid of the computer which left the teacher more time for more important tasks. All the teacher had to do was to say: read chapter so and so in the book and run programmes 1-5. Then he could go on to present more important subject matter. In other words, the computer gave him more time for the introduction of new areas.

In Dartmouth there are 150 terminals distributed between 25 buildings on the campus. During a typical day about 2 000 users can check in on the system. Thanks to the large number of terminals we acquired a surplus capacity. To prevent the data power lying idle we applied for and obtained a grant from the National Science Foundation to spread the system in New England to the lower school levels (including secondary schools). There are now five regional sub-branches which also cross the boundaries into other states . The system is used by about 10 000 students.

Our point of departure for using the computer in teaching was that the computer-aided activity should form a natural part of the teaching process, as natural a part as, say a library. In the case of the faculty members the availability of data power can give rise to a so-called spin-off effect in the form of increased research because they do not have to apply for special funds to be able to do research with the aid of the computer.

This research can then have results which gain the University grants e.g. from federal funds.

This generosity on the part of the University regarding the use of computer facilities is connected with the fact that Dartmouth received the computer free of charge from General Electric as a kind of gesture of gratitude for our evolution of a workable time sharing system. If the University had had to buy the computer the costs would by now amount to some 1 3/4 million dollars. As it is, computer costs now stand at no more than about 500 000 dollars.

We regard it as a factor of strength that the Dartmouth system is tailor-made for primary use within education. Another advantage of the system is that it is subject to constant revision because students and teachers from all faculties are continually using the programmes. In this way errors and inadvertencies in the programmes are more easily spotted and rectified.

Off-the-peg CAI programmes involve certain problems. It is difficult to make them so general that they do not need to be adapted for use within particular sectors. We fiil that we are solving this problem by letting everybody who uses the computer tailor his own CAI material. Partly for this reason we are running a special project, COMPUTE, in which the teachers produce material for their courses with the aid of the computer.

As I have already indicated, certain lower school levels are also included in the system. We are now going to test certain parts of Pat Suppes' material and adjust it to the time sharing system.

Question: Do you have a management information system at the Universtity?

Byrne: The President of the University, Dr. Kemeny, who is one of the foremost experts in the data sector, is at present assembling a working party to try and evolve a management information system. Kemeny hopes to be able with the aid of a mini-computer for administrative routines and the University's large computer (time sharing) to create a model of the University's planning and administration with all the variables needed to forecast e.g. the development of pupil numbers and so on. In this way he hopes to find the answers to many what-will-happen-if questions. Even now the computer is being used to forecast how many of those enrolling in different courses will complete them. For instance, the computer is being used in the physical education sector to analyse the possibility of winning against other football teams (believe it or not).

We are also contemplating the idea of using the computer to envolve a selection system for applicants to Dartmouth, Yale and a number of other universities sharing the same catchment area. The main component of the system would entail evaluating the applicant's preferences and informing him of his prospects of being admitted to the universities included in his list. This could be termed a form of study and a vocational guidance.

"COMPUTERS IN SCHOOLS" (DIS) - Pilot Study 2

Background

It would be difficult to overstate the importance of computer techniques in commerce and industry and in public administration. Although it was not until the 1950s that computers began to be used seriously, computer techniques have already come to dominate developments in a wide variety of social sectors. No single aid or invention has ever made such a swift impact or led to such far-reaching transformations.

One large and important field of society has been relatively unaffected by computer techniques: schools and the educational sector. Our national school system comprises 1.3 million pupils, 100 000 teachers and 5 000 schools and has a total budget of about Skr 9 billion. Accordingly it is somewhat surprising that greater use has not been made of computer techniques in this sector, for the rationalization requirements which have been the decisive factor in the introduction and diffusion of computer techniques in other sectors are also evident in the field of education. However, there is a great deal to suggest that computer techniques will also be utilized in the educational sector within the near future.

Since the end of the 1950s, experiments and research have been in progress within the sector which for the sake of simplicity can be termed 'computers in schools", in Swedish "Datorn i skolan (DIS). The computer activities concerned are many and varied and affect a wide variety of sectors in the educational system. Computers have been used in schools in England, Germany, Japan and Sweden too. A preliminary account of the uses to which computers have so far been put has been given in Pilot Study no. 1 (9.12.70) and in a report on a study visit to the U.S.A. (15.12.71).

Aim

The purpose of Pilot Study 2 is as follows:

1 to provide a survey of the use now being made of computers in schools and education

2 to evaluate the experience gained

3 to suggest action to be taken

The above division is only tentative. No hard and fast lines can be drawn between the different areas of application. In certain American CMI projects, for instance, the computer is used both as an educational aid and control member (for marking, registrering tests etc.) and as a teaching aid (computer-assisted instruction). If the computer is used for simulation support this may concern sector 2.1.1, but simulation also occurs in CAI (sector 2.2). Ultimately it is to be expected that the same computer (mini-computer/terminal) will be used for many different purposes in schools. At present, however, some form of division remains a practical advantage, among other things for the sake of simplicity and convenience of arrangement.

Summary[1] concerning the use of the computer for purposes of school administration

Within the DIS sector it is above all the instructional use of the computer that attracts attention and large research grants. Yet in fact the computer is mainly used for administrative purposes. For some time now extensive work has been in progress in the U.S.A. on the use of the computer in school administration. Both universities and ordinary schools are trying to employ the computer as an aid. The work which is being done entails the construction of local computer systems as well as computer networks. The bulk of co-operation in the latter respects centres on the hardware, but in many quarters there are also plans for co-operation regarding software and systems.

Both in Chicago and elsewhere in the U.S.A. where the computer has been tested as an administrative aid in schools, an optimistic view is taken of the possibility of harnessing computer techniques in this context even though it is as yet hard to establish any financial savings resulting from the change-over to computers.

So far relatively little experience has been gained in Sweden within this sector. Such experience as has been acquired to date, e.g. in municipal schools for adults, where pupil, teacher and student grant registration together with various other routines have been computerized, has been favourable.

One prime condition for the utilization of computers in school administration is that highly comprehensive planning and rationalization work must be feasible at low cost. We know from industry and commerce that the introduction of computers in a firm has not invariably resulted in greater efficiency and lower administrative costs. One survey shows that only in about 40 per cent of cases can firms establish direct rationalization savings resulting from the adoption of computerized administration.

1) The Swedish report gives sector-by-sector summaries of the utilization of computers and the experience gained thereby in the USA, Sweden and some other countries. Space will only permit the inclusion of the summaries in the English edition.

Summary: the computer used in information and documentation systems

Computerized information and documentation systems have existed for some years e.g. in technology, medicine and communications. In the educational sector too, a large system, the American ERIC, of international importance has been built up. The services of this system are utilized in Sweden, among other countries.

The LIBRIS system contains the embryo of a common computerized information system for Swedish research libraries. The possibilities of international co-ordination and co-operation will be kept under observation.

There are plans at international level for the development of two wide-ranging IoD systems - UNISIST and EUDISED. The first of these is primarily intended to cover the natural sciences and technology, while EUDISED is planned mainly to focus on pedagogics.

The IoD systems, which to begin with were exclusively retrieval-oriented (comprising indexing and "abstracting"), have now been developed with a view to analytical processes (the dissemination and utilization of knowledge).

This sector has great development possibilities. There is every reason for closely following up and in every possible way supporting the initiatives taken within it.

Summary: the computer as a calculator

In most parts of the world where the computer has begun to be used purely as a calculator, pupils have been given an introduction to computer techniques and in some cases computer training as well. In many cases this instruction has also included training both teachers and pupils in the rudiments of compiling a computer programme which can then be used for calculation purposes. In some cases this instruction has been taken one stage further to include certain elements of drill and practice exercises.

Pupils who begin by using the computer for calculation purposes accumulate a knowledge of computer techniques which can later be used in various ways, be it in calculation tasks, simulation support or computer-supported teaching programmes.

We therefore have very good grounds for supposing that the computer will come to play an important part as an aid to calculation in teaching, especially in technical subjects, mathematics and other subjects requiring a great deal of calculation. The main need is not only to develop programmes suitable for use in schools but also to integrate these programmes with teaching generally. Teacher training is another task to which a great deal of time and attention will have to be devoted.

Conclusion

The National Board of Education should initiate experiments to test the potentialities of the computer in pre-eminently technical subjects, mathematics and physics. Experiments at grassroots level should be aimed at eliciting answers to the following questions:

a) Which subject sectors, subjects and subject items are of such a kind as to make computer equipment of the utmost value to pupil and teacher?

b) What kind of software is to be used (ready-made programmes, programmes provisionally compiled by the teacher, simple practice programmes produced by the pupil)?

c) How is the computer to be integrated with the subject (a practical and pedagogical problem)?

d) How are teachers to be given further training and how are pupils to be informed?

Summary: computer-supported simulation

The use of the computer as a support for simulation and games can be said to have had good results in the U.S.A. and elsewhere compared to the results obtained in other school sectors of application. In the teaching of economics subjects the computer is already to be regarded as a necessary aid which helps to enhance both concretion and pupil motivation. The computer is used in this connection 1) to store information which is used for subsequent decisions, 2) to analyse portions of this information as required, 3) to produce simulation models giving the pupil a more concrete insight into the decision situations which frequently confront e.g. the manager of a firm.

The advantages of computerized simulator models are e.g. that they enable the pupil 1) to familiarize himself with the situation that arises, 2) to take decisions on a relatively realistic basis, 3) to perceive the consequences of those decisions in due course, 4) to make further decisions on the basis of this perception. One often neglected advantage is that the computer makes it possible for the pupil to obtain a pattern of action which he can follow in spite of the abundance of variables.

Other advantages offered by computer simulation and computerised games include the following:

1. Parts of subjects which today are pre-minently theoretical and are often presented in the form of descriptions, lectures, instructional lessons can be concretized in such a way as to enable the pupil to see now different structures are built up, how different quantities of data create trends and how he can take and see the results of certain decisions in the light of selected information.

2. Computerized simulation gives a simultaneous practice effect which is often lacking in the ordinary lecture or classroom situation.

3. When pupils are presented with relevant data and then placed in a situation where they have to make decisions, a high degree of motivation is created for their studies.

4. The pupil can work through the computerized game regardless of time and the availablilty of teachers.

Computerized simulation also provides an opportunity for practising a species of time-compression technique, i.e. a method whereby the pupil can telescope the time elapsing between two decisions. Thus the decisions which have to be taken by a managing director over a period of 20 years can be reduced to four hours or less with the aid of a computer. The time compression technique is often part of the simulation method and is used e.g. in connection with agricultural planning, in environment conservation and in other sectors. An experiment predominantly concerned with time-compression techniques is now in progress at the University of Michigan, where experts are being taught how to evaluate training programmes, school forms and systems. In other words, an attempt is being made to investigate and if possible predict the value of a certain instruction. The aim is to evolve by simulation certain methods or alternatives which are most suitable for the solution of a particular problem.

The computer provides the pupil with an opportunity of dealing with very complex relations which can include hundreds of variables and which he would otherwise have no chance of working on. Computerized simulation and computerized games can be regarded as a key or test sector of the educational potential of the computer. The experience gained so far is highly promising and on these grounds alone one can even go so far as to say that there is a future in the hidebound and much maligned computerized instruction which instead of utilizing this technique has often been occupied with presenting the pupil with a gobbet of information at a time and then asking questions and letting him give short answers. Computerized simulation harnesses the potential of the computer in a completely different way from so-called computer-assisted instruction.

Conclusion

Educationalists who have tested computerized simulation or computer-supported games have been highly favourable in their pronouncements. Computerized simulation is viewed practically unanimously as a sector with great development potential.

Summary: the computer as a pedagogical support and control member

This is a difficult sector to define. The computer activities involved are not peculiar to it. One of the commonest terms, CMI (Computer Managed Instruction) is highly ambiguous. Some American projects, e.g. the PLAN project, use the computer

merely as a feedback device which teachers and pupils can use to find out the pupils' test and examination resluts. The computer is also used to provide curricular instructions, directions and aids, teaching materials and suchlike.

In the PLAN project pupils are to work with conventional and commercial teaching materials which are not computer-based.

The IPI project also includes the above mentioned elements but combines them with computer supported teaching, i.e. the pupil is also given courses and material via the computer, including material specially constructed for the pupils taking part in the experiment. In the latter case elements of CAI (computer-assisted instruction) are also included.

The advantages which are thought to accrue from CMI are as follows:

1. Many time-consuming administrative and informative routines performed by a teacher in the classroom and outside it can probably be reduced or simplified through CMI.

2. The pupils' motivation for a subject is increased by prompt feedback, i.e. giving them the results of different tests and at the same time letting them know what more they should read to improve their knowledge, remedy their deficiencies or deepen their understanding of a subject.

3. CMI gives both teacher and pupil a better chance of individualizing instruction. There are good grounds for saying that teachers today have neither the time nor the administrative resources for more differentiated or individualized instruction)learning in the classroom or outside it.

4. Another advantage of CMI is that the teacher can immediately correct his teaching when he finds out how pupils have reacted in certain computer tests. Thus he can revise certain items, give certain pupils extra training and so on. Certain educationalists are of the opinion that CMI simplifies goal analysis. Others,however,are more critical and feel that goal analysis conducted with the aid of CMI is liable to attach undue importance to purely cognitive goals. This would give goal analysis an unwelcome cognitive bias.

There are, however, considerable difficulties to be overcome within the CMI sector. One such difficulty lies in deciding what data concerning the pupil are to be included in an individual system of CMI character. Thus certain experts feel that the data built up within the CMI system and consisting of test data of various kinds are sufficient. Others contend that data concerning the pupil's socio-economic background and his mental and emotional maturity should also be included. But it is very difficult, for reasons of discretion, for data of this kind to be included. Owing to our inadequate insight into the teaching

and learning processes, it is extremely difficult to produce a tailor-made system and assume that the pupil will be able to cope with a certain type of performance or with particular tasks or test items. It is even asserted that this prediction of the next step to be taken by the pupil is in itself a major problem.

CMI is not thought to work very well unless certain conditions are satisfied:

Teaching in the classroom and outside it must have been carefully planned and this can only be done in the form of a detailed analysis of what is included in the teaching concerned, i.e. the items involved, the methods and teaching materials that are relevant and available, and the capacity of the pupil category in question for independently coping with certain tasks. CMI presupposes a knowledge of what ought preferably to be presented in the classroom together with other pupils and what tasks are of a more individualized nature. By all accounts the CMI system constructed must be tailor-made to suit the pupils and the instruction involved.

Computerized marking or optical reading with the aid of a computer can be seen as a subsidiary sector of CMI. This form of computerization can involve the administration of certain tests to the pupil. The computer then registers the pupil's answers, marks them and works out the score. On the basis of his answers, the pupil is given a diagnosis of his knowledge at a particular moment. The test may be of a preliminary or diagnostic nature.

One quite promising venture is the so-called sequence testing which has been tried out at Florida State University. In this form of testing the computer programme takes into account not only the answers previously given by the pupil but also the degree of certainty and knowledge exhibited by him. The computer also registers answering times and the pupil is offered a certain test item in the next step based on his previous item.

This can mean that a pupil who answers very quickly or very well is given a special test item. It can also mean that a pupil who answers correctly and rapidly all the time is given a smaller number of test items. In this way the test stage or test can be abbreviated. This sector should be amenable to considerable development. Sequence testing is an extremely interesting aspect of developments in the field of computer-assisted-instruction.

The experiments conducted in the U.S.A. with computer-based study and vocational guidance have above all been aimed at making the pupil more motivated for the question of choosing a career and at the same time giving him a real chance of independently appraising study alternatives and occupational sectors. It has also enabled him to familiarize himself with

more sectors than would be possible in the time allotted to conventional teaching. The results so far are promising.

Conclusion

The National Board of Education should encourage and initiate research and development in this sector, especially as regards computer based study and vocational guidance. It is extremely difficult to keep the factual content of study and vocational guidance material up to date. It is also difficult to supply all pupils promptly with correct study and vocational guidance information.

The proposed pilot survey should therefore be made to include an inventory of current problems connected with computer-based study and vocational guidance.

Summary : computer-assisted-instruction (CAI)

Of all the subsidiary sectors considered in this Pilot Study CAI has involved the largest number of experiments and the heaviest research commitment. Most of the grants awarded in the U.S.A. for computer-based experiments in the educational sector have gone to CAI. In spite of the broad range of investment in research and development, many important problems still remain to be solved. Thus, no computer equipment is at present available at a price which schools can afford.

One often hears that the potential resources of the computer have not been fully harnessed in CAI programmes. The programmes developed for the computer have not differed very much as regards content and disposition from those already presented via simple teaching machines. The criticism formerly levelled against programmed instruction for not being well-integrated with other activities in the subject concerned can also be applied to CAI. The importance of a very careful choice of sections, items etc. with characteristics rendering them suitable for presentation and learning via computers has been stressed in many quarters.

Nonetheless there is every reason for high hopes e.g. regarding the CAI experiments included in the PLATO project at the University of Illinois. Don Bitzer, the PLATO project leader, has proceeded on the assumption that CAI (or as he terms it CBI/Computer Based Instruction) cannot be utilized within the educational sector until a radically simple, inexpensive and reliable pupil terminal has been developed. Another positive trend is that many researchers have now realized the importance of a careful choice of pupil category, subject and subject section for the application of CAI.

Conclusion

Technically speaking, a simple and inexpensive pupil terminal with CAI screen and sound equipment has yet to be developed. Pedagogically speaking it still remains to develop CAI programmes utilizing the potential teaching resources of the computer.

3 Computer education

The reason why computer education has been broached in this context in the first place is to be found in the possibilities of combined utilization of computer equipment, systems and software and the interchange of computer activities and computer experience that could occur between computer education and other computer activities in school.

The rapid technical development of mini-computers together with greatly reduced prices (an annual reduction of between 25 and 50 per cent is said to be likely) makes it possible for computer equipment to be used for computer orientation e.g. in the technical line of upper secondary school. In this way a bridge can be thrown between computer orientation and computer-managed instruction, e.g. by the utilization of the computer as a calculator or as an aid to simulation and games.

3.1 Computer training

At present computer training is vocationally oriented and takes the form of a higher specialized course for programmers and systems men. This course is held at about fifteen upper secondary schools. This training is in need of extension, in the first instance so as to include real-time-techniques. This in turn raises the need for terminals/mini-computers for instructional purposes. If such equipment were to be acquired for upper secondary schools, computer equipment could be shared by the various data activities occurring in schools.

3.2 Computer orientation

Pursuant to the letter of 30.6.71 from the King in Council, an internal working party has been set up at the National Board of Education to investigate the appropriate manner in which computer orientation can be designed in comprehensive and upper secondary schools. The working party is also to arrange for the compilation of syllabi and more detailed instructions for the conduct of computer orientation. Experimental activities will probably be proposed for testing syllabi.

The experiences reported by Swedish schools which have used computer equipment reveal that the computer is extremely useful for calculation tasks and simulation support in technical and scientific subjects. Experience of the use of the computer as a calculator in combination with computer orientation will be derived from the joint experimental activity begun during the autumn by the City of Stockholm Education Authority and the National Board of Education.

4 The potential applications of the computer in Schools - summary

So far only limited use has been made of computers and computer techniques in schools. Computers have been mostly employed for purposes of school administration. Many school districts in the U.S.A. have computerized the registration of teachers, other school personnel, pupils, merit reports etc. In Sweden it is mainly municipal schools for adults that have computerized certain registration tasks. Planning and administration in schools today are in great need of rational aids. There would appear to be good prospects of computers being used in school planning and administration with a view to rationalization.

For some years now, computer-based information and documentation systems (IoD systems) have been used in technology, medicine and education in the U.S.A., Sweden and other countries. The Swedish LIBRIS system contains the embryo of a common computer based information system for Swedish research libraries.

The computer already plays a certain part in teaching as a calculation aid, especially in the case of technical and scientific subjects requiring extensive calculations. The computer used as a calculator is regarded in the U.S.A as an indispensable aid in higher education. Computer-supported games and computer-based simulation are another sector which can display promising results and which evinces great development possibilities.

The computer used as an educational support and control number is thought to offer help in time-consuming administrative and informative routines which are often incumbent on teachers, but there are certain difficulties that will have to be overcome before the computer can play a more important part.

One interesting sub-sector is study and vocational guidance, where relatively promising results have been obtained using computer based systems. At present, using conventional methods, it is difficult to give all pupils correct study and vocational guidance information. Computer techniques may prove extremely helpful in this respect.

Most experiments within the DIS sector have been concerned with computer-assisted instruction (CAI). One frequent criticism has been that the potential resources of the computer have not yet been harnessed in CAI. New attitudes are gaining ground, however, and the University of Illinois PLATO project, among others, shows a certain amount of promise for the future.

As regards the teaching of computer techniques (computer instruction), a new form of training (instruction in real-time programming) is needed in computer training. This in turn

calls among other things for terminal equipment. The prime requisite for computer orientation in comprehensive school and upper secondary school is syllabi and more detailed instructions concerning the organization of teaching. Access to some form of computer equipment is also desirable, particularly in upper secondary schools.

6 Measures proposed

Computer techniques are developing at increasing speed. Computer capacity is increasing at the same time as apparatus is becoming less bulky (mini-computers) and prices are falling steeply. This trend will probably result in computers becoming a standard item in the educational sector within the near future.

It is therefore high time that the National Board of Education began to grapple seriously with the problems which will fairly soon arise when computer techniques begin to be harnessed on a large scale for both administrative and educational purposes in the school sector. There is already an urgent need for the accumulation by the Board of a fund of know-how in readiness for the probably revolutionary changes that the increased use of the computer will entail.

Ten years' American experience in the DIS sector with a commitment of several hundred million dollars has failed to produce the results that were hoped for. To a great extent this is because developments have moved too quickly in relation to technical equipment, costs etc. and because the computer has been used in an excessively conventional manner, i.e. as an aid, without utilizing its potential resources and without applying it to the special tasks existing in schools and the educational sector. But the main cause would seem to lie in diffuse, unco-ordinated experiments with no central body to co-ordinate the various projects.

The National Board of Education, together with the two associations of local authorities should therefore act on American experiences as soon as possible by tackling the entire range of problems arising when efforts are made to utilize the computer for several different purposes in individual schools and types of schools with different sponsors which can nonetheless pool computer resources and experience. The Board should endeavour to direct developments in the DIS sector and to do so together with the associations of local authorities, who for obvious reasons are bound to be the main interested party with regard to the local and regional data activities which can come into question.

Together with the associations, the Board should initiate a pilot survey to provide a more concrete inventory of activities in school administration and teaching which can be successfully

computerized. The pilot survey group which it is thus proposed to set up should also investigate the practicability of model experiments in a particular municipality. If such experiments are deemed practicable, the project group should also compile suggestions for experimental activities (model experiments).

The proposals put forward concerning an investigation of the utilization of computers in the study and vocational guidance sector (see item 6.2) should be borne in mind and if possible incorporated in the pilot survey.

Other measures may also be called for on the strength of the pilot study.

As regards computer orientation, pursuant to a letter from the King in Council dated 30.6.71, an internal working party has been set up within the National Board of Education mainly for the purpose of drawing up syllabi and more detailed instructions regarding computer orientation in comprehensive school and upper secondary school.

In this connection the DIS group feel that particular emphasis should be placed on the following:

Consideration should be given to the possibility of pooling computer equipment. In view of the exceedingly rapid pace of technical development in this sector, it is reasonable to suppose that mini-computer equipment which is quite expensive at present will come within the course of a few years to occupy the same price class as electronic calculators today. Apart from administrative and purely instructional tasks, it should also be possible to use the same equipment for computer orientation. It is extremely important for opportunities for pooling computer resources in schools and municipalities to be taken, especially in the early stages. The pilot survey proposed above must therefore be planned in such a way as to shed light on these matters.

One of the major problems in computer orientation concerns the in-service training sector. At present both comprehensive school and upper secondary school teachers have little knowledge of computer techniques and their effects and they must therefore be given in-service training on the subject. This is particularly true of mathematics, physics, electricity and civics teachers in upper secondary school, who need to be given comprehensive in-service training to enable them to teach their pupils about computer techniques. Suitable in-service training material will also have to be developed. The National Board of Education should also arrange for the production of computer orientation teaching materials which can be used in comprehensive school and upper secondary school.

6.1 The project "Computers in the School Municipality" - draft project plan

Background

So far computers have been used experimentally in schools for a host of different tasks. The following sectors of application were enumerated in Pilot Study Report 2:

1. The computer in administration and information

1.1 school administration

1.2 information and documentation systems

2. The computer in teaching

2.1 Computer-supported instruction

2.1.1 the computer as calculator - computer-supported simulation

2.1.2 as an educational support and control member

2.2 computer-assisted instruction (CAI).

It is emphasized in many connections that computer techniques have been found to require heavy personnel and material investments. This should be a major consideration within the school sector, for, compared to a firm or enterprise about to introduce computer based systems, schools and the educational sector present what from the point of view of computer systems is a rather complex structure. Moreover relatively little experience has so far been gained of the use of computers in schools.

One fundamental condition for the successful utilization of computers in the school sector would therefore seem to be a carefully study together with comprehensive planning of the sector in which it is proposed to introduce computer based administrative or instructional systems. This study should also include an investigation of the possibilities of computer resources used in one sector also being applied to another, i.e. of bridging the gaps between sectors.

The basic idea of bridging the gaps between different spheres of application is an important item in the proposals for experimental activities with "Computers in the School Municipality" outlined below.

Summary of the motives for the project "Computers in the School Municipality"

1. Experience of the administrative utilization of computers in a school municipality is of interest to all school municipalities and, accordingly, for central planning and information as well.

2. Experience of the computer as an aid to teaching, i.e. the educational role of the computer (e.g. jointly with the utilization of computers for administrative purposes) is of the utmost central interest.

3. The introduction of computers in the school municipality also has a bearing on information to teachers and pupils regarding computer techniques. The National Board of Education is increasing its commitments in the field of computer studies or computer orientation. Experience of this implementation of computers will be of value to the entire DIS sector.

4. A large number of municipalities and computer firms have expressed interest in taking part in projects in the DIS sector. Projects conducted independently and without any coordination are liable to result in separate computer systems which are not even partially susceptible of general application. Great importance must be attached to the initiation by the National Board of Education, together with the associations of local authorities, of experiments leading to generally applicable solutions.

Aim of the project

The aim of this pilot survey is to decide whether computer techniques can help to effectivize and rationalize local school administration activities and also to determine which routines can profit by using the same or parts of the same computer capacity. These may include certain tasks of school administration, e.g. teacher and pupil registration, and certain pedagogical activities, e.g. within the study and vocational guidance sector (see item 6.2), computer-supported simulation etc. The computer activities investigated should be such as can be said to be of general interest. Typically local elements should be avoided.

A pilot survey due to begin during the spring of 1972 will investigate the possibility of experimental activities to test the following working hypotheses:

The introduction of computer based systems will mean:

1. Better information retrieval for planning and administration

2. Greater efficiency in school administration

3. Better resources for the individualization of instruction

Pilot survey

The pilot survey due to begin in the spring of 1972 will investigate the conditions for the utilization of computers in a model municipality (suitable population 70 000 - 100 000).

The aim of this pilot survey is

to describe problem sectors

to describe possible rationalization measures

to draw up a cost estimate.

With a view to a possible implementation on a larger scale, the model experiment (main study) will also provide a basis on which to decide, among other things

1. To what use the computer can be put by the school municipality in school administration and pedagogical administration.

2. The potential use of a mini-computer/terminal in school and in the municipality.

3. The importance and value of access to a mini-computer/terminal for computer training and orientation in comprehensive school and upper secondary school.

4. The importance and value of access to a mini-computer/terminal for in-service computer training for teachers.

Basic outline of the project

The pilot survey designed to investigate the possible use of computers is being jointly conducted by the National Board of Education and the associations of local authorities. A special working party, "the pilot survey group" is being set up (composition etc. overleaf).

One of the tasks of the pilot survey will be to determine the practicability of a model experiment in the municipality. If such an experiment is found to be practicable, the project group will go on to draft a plan of experimental activities (model experiments). As the main study proceeds, further decisions will be successively taken concerning the design and possible continuation of the experiment.

Rough time schedule

Pilot survey	spring term 1972 - autumn term 1972
Design of the experiment (main study)	autumn term 1972 - spring term 1973
Commencement of model experiment (on a limited scale)	autumn term 1973 - spring term 1974
Model experiments (full scale)	autumn term 1974 - spring term 1975
Revision of routines, evaluation	autumn term 1975 - spring term 1976
Follow-up, final report, decision	autumn term 1976 - spring term 1977

Project organization

The pilot survey is being conducted by a project group, "the pilot survey group", comprising planning, systematization and educational expertise. The pilot survey group is being nominated by the National Board of Education together with the associations of local authorities. The work of the pilot survey group will be directed and accounted for by the DIS group together with representatives of the associations of local authorities and the National Office for Administrative Rationalization and Economy.

The question of a new main study and a new project organization will be determined by the National Board of Education and the associations of local authorities in the light of the results of the pilot survey.

It is important for the pilot survey group to take note of activities in the DIS sector which are in progress elsewhere (e.g. at the National Board of Education). Thus matters concerning the use of computers for information retrieval e.g. in central and local planning and administration come within the PLAN and INFO spheres of operations, so that the work of the pilot survey group should be made to tie in with surveys at present being conducted by those working parties.

Assuming that the pilot survey group recommends a main study within the sector, guidelines and more specific directives for a model experiment will be drawn up by the DIS group in collaboration with the associations of local authorities and the National Office for Administrative Rationalization and Economy. The DIS group will also put forward proposals regarding the composition of a project group and steering committee for the main study (model experiment).

Once practical operations begin to be established in a large number of schools, it is of the utmost importance for the

hardware to be sufficiently uniform to permit the use of the same programme ware. A strict centralization of development work and purchasing is thus called for. The National Board of Education, the associations of local authorities and the National Office for Administrative Rationalization and Economy should be given a deciding influence in this decision process.

Costs

At present only the costs of the pilot survey can be accounted for. The pilot survey is expected to require about six months' work.

Outside personnel:

school administrator	6 personnel months x 7 000:-	42,000:-
planning expert	6 personnel months x 7,000:-	42,000:-
systematization expert	6 personnel months x 7,000:-	42,000:-
study and vocational guidance expert (see item 6.2)	4 personnel months x 6,000	24,000:-
		150,000:-
Lkp		36,000:-
		186,000:-
travel expenses		10,000:-
miscellaneous costs		15,000:-
	Total Skr	211,000:-

6.2 The computer in study and vocational guidance - survey proposals

Background

One of the aims of the study and vocational guidance (shortened: syo) programme is to give pupils allround objective information on educational opportunities, working life and the labour market and to teach them to make critical and independent use of this information in choice situations during their school careers and subsequently. This material is very extensive and varied in character and considerable pedagogical problems are encountered e.g. in the teaching of decision techniques. Efficient

individualized instruction in this context presupposes an abundance of teaching and guidance time, often more than is feasible in present-day conditions. This makes it natural to consider whether the capacity of the computer for providing immediate and comprehensive information in large quantities and for presenting sectors of information in varied combinations could not be utilized by pupils, teachers and counsellors. In the U.S.A. favourable experience has been gained of the use of computers in the syo sector. We therefore propose that closer consideration be given to the following project suggestions.

The computer as an individual aid for information concerning work tasks and working conditions

One of the aims of vocational guidance in schools is to teach pupils to locate, analyse and assess information concerning different occupations and educational opportunities in relation to their own desires, interests and aptitudes. To this end efforts are made to start with a discussion of different types of work tasks ("occupational functions") occurring in various combinations in different occupations and of working environments end spheres of activity. See e.g. Fb SYO 2b; "Choosing for Yourself". This means among other things that pupils should be actively trained in formulating individually relevant "search questions" and making use of various kinds of careers information. Different kinds of training booklets and other teaching materials are used for this purpose - see e.g. the work brochure "Teach Yourself to Choose Vocational Practice".

The source material containing the facts used for this purpose is very large and consists of many publications offering different kinds of information and emanating from different publishers. The basic material consists of the Labour Market Board's publications Swedish Occupational Cyclopaedia, Your Job and Your Future, and Employment Information together with informative publications on educational and training opportunities issued by the National Board of Education and other organizations. Other kinds of material, e.g. from firms and trade organizations, are also used. This means that information retrieval (which is often conducted in the form of group work) can take up a great deal of the pupils' time, in addition to which teaching and the above mentioned skill of formulating meaningful "search questions" are bound to be more illustrative than comprehensive.

Accordingly there may be good grounds for an investigation of the extent to which a supplement to the literature in the form of computer-based material could simplify teaching by giving rapid answers to pupils' questions, correct references to sources of information etc.

The computer material and its utilization

Basically the computer material would be organized on the same lines as in documentation work. The items would of course be occupations and educational opportunities described by several concepts, e.g. occupational function, sphere of activity, working environment, educational level, labour market characteristics. By formulating individual search questions in the concepts included (variables) under the teacher's guidance and testing them (individually or in groups) in the computers, pupils could rapidly obtain and compare different groups of occupations and also obtain references for further information.

Anticipated effects

The use of computers could make for greater individualization of instruction to suit the interests and ability of the pupil and it could also facilitate a more exhaustive presentation of material. It would also relieve the teacher of a great deal of pure fact collection and material handling, thus enabling him to concentrate more on the fundamental task of teaching pupils how to put their questions regarding the choice of studies and occupations. An experiment in this direction would result in a general increase in pedagogical knowledge, since it concerns a concept formation learning which differs somewhat from "ordinary" fact learning.

The computer would seem to be by far the most efficient aid for a search process of the kind referred to above. Reference works and other printed items cannot be grouped with the requisite number of "entrances" without becoming very unwieldy in the process. The needle card or sight hole card registers now generally used as office aids can only give references, not factual information, apart from which they soon wear out.

It should be noted in this connection that computer applications of this kind require an extensive memory and combination capacity, which is exactly what the computer has to offer.

Working party

An expert is being nominated to collaborate with UA 3, the DIS group and the Labour Market Board in studying (it is suggested that the study comprise two stages) and submitting proposals on the subject as follows.

1. Development and definition of the goals of the teaching concerned, i.e. to provide pupils with a broad view of working life, free them from the "individual occupation mentality" and teach them to ask the right questions.

2. Outline (in consultation with the vocational guidance bureau of the Labour Market Board) of the system of variables with respect to the educational goal.

3. Outline of the pedagogical interaction of teacher, pupil and computer together with an investigation and suggestion of a suitable form of data presentation.

Once items 1 - 3 have been completed, an assessment can be made of the feasibility of experimental activities. If it is found that experimental activities can begin, planning of the same can start with the following measures:

1. a definition of the factual sector according to the type of school, study alternative and level to which the experiment should refer

2. the investigation and suggestion of solutions for

    1. the establishment of a data base

    2. choice of hardware, development of systems ware including search programmes

3. the compilation of a cost estimate for an initial experiment

4. the compilation of guidelines for possible experimental activity, taking into account updating problems etc.

The survey should if possible be co-ordinated with the project "Computers in the School Municipality".

Costs

1 expert x 4 months x Skr. 6,000	Skr 24,000
travel	Skr 4,000
	Skr 28,000

SUMMARY of Pilot Study 2

Hitherto computers and computer technology have not been utilized on any considerable scale in schools and the educational sector. The capacity of the computer has, however, been applied on an experimental basis to a variety of tasks. The following sectors are covered by this report:

1. Computers in administration and information

1.1 for school administration

1.2 in systems of information and documentation

2. The computer in teaching

2.1 computer-supported teaching

2.2 computer-assisted instruction (CAI)

3 Computerized teaching

Most of the experiments with computers and the application of computer techniques described in the following report have been conducted in the U.S.A., though a number of Swedish experiments are also included. (Reference is made in certain cases to experiments described in earlier reports (pilot study 1 and report on a study trip in the U.S.A.). The summaries given regarding each sector are based on all three reports.)

So far the commonest application of computers has been for purposes of school administration. Many school districts in the U.S.A. have computerized registers of teachers, other school personnel, pupils, merit reports etc. Clearly there is every possibility of computers being used for purposes of rationalization within the contexts of school planning and school administration.

Computerized information and documentation systems occur in technology, medicine and pedagogics. The Swedish LIBRIS system contains the embryo of a common information system for Swedish research libraries.

The computer is already playing a certain part as a calculator e.g. in technical and scientific subjects where pupils have to work with complex mathematical quantities. Computer-aided simulation techniques have been used with great success and there would appear to be good possibilities of further development within this sector.

As an educational support and control organ, the computer is regarded as a potential aid in the time-consuming administrative and informative routines which are often incumbent on teachers. There are however certain difficulties which will have to be overcome before the computer can play a more significant part in this context. One interesting sub-sector is that of computerized study and vocational guidance.

Most of the experiments in the DIS sector have employed computer-assisted instruction (CAI). In spite of heavy investment, little success has been scored in the majority of cases in utilizing the potentialities of the computer. A new attitude is emerging, however, with regard to the development of software utilizing the pedagogical resources which the computer can be said to offer. Consequently there is every reason for a close observation of developments in the CAI sector.

A new form of training (realtime programming) is needed for the teaching of computer techniques. Syllabi and further training for teachers are the most urgent requirements for a presentation of computer techniques in comprehensive school and upper secondary school.

Technical developments in the computer sector are moving fast, particularly as regards so-called mini-computers. Prices are falling rapidly, thus increasing the prospects of computers being utilized by schools within the relatively near future.

Experience from the U.S.A. should be utilized by the National Board of Education and the two associations of local authorities acting as soon as possible to gain an overall view of the problems encountered when attempts are made to employ computers for many different purposes in different schools and types of schools whose various sponsors in many cases can nonetheless pool their computer resources and experience. Together with the associations of local authorities, the National Board of Education should initiate a pilot survey to obtain a more specific inventory of activities in school administration and teaching which can be successfully computerized. The pilot survey group thus proposed should also investigate the feasibility of a model experiment in a particular municipality. If possible the pilot survey should also incorporate a proposal for an investigation of the utilization by the DIS group of computers in study and vocational guidance.

As regards the presentation of computer techniques, the National Board of Education, pursuant to a letter of 30.6.71 from the King in Council, has set up an internal study group whose main task will be to compile syllabi for a suitable presentation of computer techniques at comprehensive school and upper secondary school levels. It is important in this context for due consideration to be given to the possibilities of pooling computer equipment. It is also highly important for arrangements to be made as soon as possible for the further training of comprehensive school and upper secondary school teachers and for the compilation of suitable further training material.