DOCUMENT RESUME

ED 266 775 IR 011 993

TITLE	Computers in Education: An Outline of Country Experiences. Report of the Asian Seminar on Educational Technology (3rd, Tokyo, Japan, September 26-October 2, 1984).
INSTITUTION	United Nations Educational, Scientific, and Cultural Organization, Bangkok (Thailand). Regional Office for Education in Asia and the Pacific.
PUB DATE	85
NOTE	88p.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Viewpoints (120) -- Reports - Descriptive (141)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Computer Assisted Instruction; *Computer Literacy; *Computer Science Education; Computer Software; Curriculum Development; Developed Nations; Developing Nations; Elementary Secondary Education; *Foreign Countries; Instructional Innovation; International Organizations; *Microcomputers; Seminars; Teacher Education; Technological Advancement
IDENTIFIERS	*Asia; *Computer Uses in Education

ABSTRACT

Selected country papers included in this collection focus on applications of computers in the educational systems of Australia, China, India, Japan, the Philippines, Sri Lanka, and Thailand. Information for the city of Singapore is also provided. The reports for each country and Singapore include: (1) background information on the development of computers, including infrastructures, policies, plans, programs, research, and training; (2) trends and issues in computer education; and (3) current activities in the area of educational technology. The final paper discusses the impact of microcomputers on less-developed countries and suggests a 14-point plan of action for professional societies in these countries. (JB)

[APEID] Third Asian Seminar on Educational Technology, Tokyo, 26 September – 2 October 1985.
Computers in education – an outline of country experiences. Bangkok, Unesco, 1985.
81 p. (Asian and Pacific Programme of Educational Innovation for Development)

1. COMPUTER-ASSISTED INSTRUCTION – ASIA. 2. EDUCATIONAL TECHNOLOGY – ASIA. 3. COMPUTER SCIENCE EDUCATION – ASIA. 4. COMPUTER APPLICATIONS – ASIA. I. Title. II. Series.

371.394 45

IR

APEID

Asia and the Pacific Programme of Educational Innovation for Development

COMPUTERS IN EDUCATION

An outline of country experiences

UNESCO

Unesco Regional Office
for Education in Asia and the Pacific
Bangkok, 1985

The Third Asian Seminar on Educational Technology was held in the context of the Third Programming Cycle of APEID at the Tokyo Gakugei University, Japan, from 26 September to 2 October 1984. The Seminar was organized jointly by the Japan Council of Educational Technology Centres and Unesco.

Published by the
Unesco Regional Office for Education in Asia and the Pacific
P.O. Box 1425, General Post Office
Bangkok 10500, Thailand

Printed in Thailand

The designations employed and the presentation of material throughout the publication do not imply the expression of any opinion whatsoever on the part of Unesco concerning the legal status of any country, territory, city or area or of its authorities, or concerning its frontiers or boundaries.

BKA/85/M/284-1200

INTRODUCTION

In the context of APEID, the Japan Council of Educational Technology Centres has organized several Asian Seminars on the application of educational technology. The Third Asian Seminar on Educational Technology was held during the Third Programming Cycle of APEID activities. It took place in Tokyo from 26 September - 2 October 1984, serving as a consultation meeting for specialists in the application of computers in education, with reference to Resolution No.4.1 adopted by the General Conference of Unesco at its Twenty-second Session (Reflection on world problems and future-oriented studies).

Participants of the Seminar prepared country papers comprising background information on the development of computers, including infrastructures, policies, plans, programmes, research and training; trends and issues on computer education; and current activities in their respective institutions in the aspect of educational technology. These considerations are reflected in the selected country papers included in this publication

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COUNTRY EXPERIENCES

Although some countries have had experiences of using computers - mostly mainframe - during the last two decades, the rapid development and reduction in cost of microcomputers since about 1979-1980 is now having its effect. Both Australia and Japan record a lack of co-ordination and the need for systematic training. The Commonwealth Schools Commission in Australia has, as a result of the recommendations of its Advisory Committee, concluded that large expenditure is urgent and necessary to overcome the deficiencies in computer education. Japan has recognized the need to reorganize teacher training and curricula for computer literacy, systems application and management skills. India reports an acute shortage of personnel and is hampered in its efforts to train new staff because of the lack of trained teachers. Funding is also a problem. China is relying on donations from colleges, research institutions and enterprises, while India is making efforts to find funds to set up or modernize educational administration.

Computers are being introduced into the school system from primary to higher education. The rapidity with which microcomputers have been assimilated into schools in Australia is exemplified by the statistics from the state of Queensland. In 1981 there were 160 schools with 310 computers - in 1983 there were 420 schools with 1,550 computers. This explosion, as in other states, has occurred mainly at the primary school level. In contrast, Japan reports that fewer than 0.1 per cent of schools have computers and that examples of computer assisted instruction (CAI) are rare. However it is predicted that there will be rapid changes in the near future due to decreasing costs. In the Philippines the general education curriculum programme has a component called 'Computers in Society'. In Thailand the Institute for the Promotion of Teaching Science and Technology (IPST) is engaged in developing the curriculum, and the materials, for a computer education programme, while at the same time carrying out teacher training in universities and teacher colleges. The other countries are also carrying out teacher training - with India, Philippines and Thailand conducting degree programmes. In Sri Lanka, hardware suppliers provide the equipment and universities the staff for teacher training. In Thailand, computer companies also provide training programmes.

All countries report growing government support including the removal of restrictions on purchasing equipment (Philippines and Sri Lanka), and the inclusion of the use of computers in education in their development programmes (India and Thailand). In China the government gives priority to the development of computers. China, India and the Philippines are engaged in the manufacture of microcomputers, microprocessors and semi-conductors.

AUSTRALIA

Background and early developments in computer education

Australia does not have a national education system. Under the constitution, schools are a responsibility of the different States, though the Commonwealth Government, through the Schools Commission, makes annual grants across a wide number of programmes. With six States and two Territories, there are thus eight separate authorities which determine the direction of computer education in government schools. Non-government schools are largely free to determine their own directions. At the tertiary level, universities and colleges of advanced education are autonomous bodies with freedom to develop their own courses according to perceived needs.

Computers have been used in Australian schools for teaching and administration for more than a decade, and in universities mainly as research tools for much longer. At the beginning of 1983, however, the Commonwealth Schools Commission argued that such was the importance of computer education to the country's future that federal funds should be made available to augment what the States were doing. The President of the Australian Computer Society expressed similar sentiments when he stated:

> We are, without doubt, on the threshold of the most revolutionary set of technological innovations that humankind has yet had to deal with. As a

nation it behoves us to carefully and thoughtfully consider the future we want for ourselves and for our children (Goldsworthy, 1983: 4).

This section describes briefly the awakening of interest in computer education in schools or, as it is commonly referred to, schools computing.

An early report on the state of computers in education across the nation was Computers and Teaching in Australia (Wearing et al. 1976). While this report was intended to promote discussions among computer users, it was several years before any further national study of computers in schools was undertaken. The impact of microcomputers was beginning, though, to be felt in Australia by 1979 and the Australian Computer Society published a monograph entitled The Microcomputer Revolution (Caelli, 1979). The social implications of the new technology for education were noted but nc revolutions were reported taking place in Australian classrooms.

Not until 1982 did further reports specifically examine the question of computing in schools. The Keeves Report (Keeves, 1982), for instance, strongly advocated courses to provide an introduction to new technologies - courses like technological studies, engineering science, modern industry, computing, and computer science. Also in 1982, a national research study was commissioned "to consider where computers are relevant to the education systems" (Brownell et al., 1982); a review on education and the new technologies, sponsored by the Organization for Economic Co-operation and Development (OECD), appeared a few months later (Brownell, 1982); and a widely cited paper by Sandery (1982a) examined the future role of computers in education.

The climate was now changing swiftly and educational historians are likely to describe 1983 as the watershed. Three major reports followed in quick succession: one a report to the Minister of Education in Victoria (Shears and Dale, 1983) canvassing a wide range of issues, a second the report of the National Advisory Committee on Computers in Schools to the Commonwealth Schools Commission (1983b), and the third a review on computing in schools commissioned by the Australian Council for Educational Research (Anderson, 1984). Of these, the Schools Commission Report with its recommendations for a national Computer Education Programme for the period 1984 to 1986 has already acted as a catalyst for change in those parts of the country where little co-ordination was previously apparent.

Trends and issues at the schools level

By the end of the 1983 school year the majority of secondary schools in Australia had at least one microcomputer (Commonwealth Schools Commission 1983b). The number of computers in primary schools also rapidly increased with schools estimated as having one machine reaching as high as 50 per cent in Tasmania (Scott 1983a). There are, however, marked differences between States, as Hoffman (1982) observed:

> Indeed it is quite obvious that there are already significant differences amongst the Australian States in the priority that each assigns to information technology education, the resources allocated and the policies being implemented. (Hoffman, 1982: 81)

Developments at the state level. The first obvious difference between States is that some have supported computing in schools over a much longer period than others (Brownell, 1982). South Australia established a co-ordinating centre as early as 1968. This is the Angle Park Computing Centre, one feature of which is that it provides a service to all schools, government and non-government, as well as a service for some years to the Northern Territory. Tasmania established the Elizabeth Computer Centre in 1975 and a statewide time-sharing network. Western Australia followed with the establishment of the Schools Computing Centre in 1977. In the Australian Capital Territory the Schools Authority also adopted a co-ordinating role with the establishment of the Computer Services Section.

During 1983, largely as a result of the Commonwealth initiatives in computer education, the remaining States either set up computer units or significantly increased the staffing levels of fledgling units. Thus a Computer Education Unit was established in Erskineville, New South Wales; a Computer Education Task Force was established at Ardoch Village in Victoria, where previously there had been a small computer centre; a Schools Computing Services Unit was set up within the Curriculum Branch of the Queensland Department of Education, which Branch has previously been involved in computer education projects; and in the Northern Territory a Computer Education Centre was established to replace services formerly provided by advisory staff in computing.

Other differences between States follow from the first. Thus a second difference is the perceived need by some States to adopt a co-ordinated, centralized aproach to computing in schools, evident in the early establishment of computer centres to provide services to schools. Beauchamp (1982), after noting computing activities in Tasmania, South Australia, Western Australia and the Australian Capital Territory, and writing before the moves to establish a national education programme, went on to observe:

> In the remainder of the states (reg[illegible] those having the largest population) there is as yet no co-ordinating authority for advising schools interested in computing. Microcomputers are appearing in a number of schools but since no common bond is being established between the

> schools a variety of different types is being purchased and little software sharing is possible between these incompatible systems and, of course, no co-ordinated approach to computer teaching methods. (Beauchamp, 1982: 56)

Some computer educators would agree with Beauchamp that education systems have a responsibility to adopt a co-ordinating role (e.g. Hoffman, 1982). In contrast to this view, however, are most of the States in the United States (exceptions being Minnesota and Alaska). Similarly, some Australian States (notably Victoria and Queensland) have adopted more of a school based approach. The argument has therefore been against establishing separate co-ordinating authorities in the past.

A third difference between States relates to the adoption of policy on computing activities in schools. Again it is the States which have been actively involved longest and which have adopted centralized approaches (e.g. Tasmania, South Australia, Western Australia), that have formulated policy (Brownell, McShane and Read, 1983; South Australian Education Department, 1982; Education Department of Western Australia, 1981, 1982). The States with larger populations (e.g. New South Wales, Victoria) have been slower to establish sets of guidelines, though New South Wales has since released a comprehensive policy statement on computers in schools (Department of Education, 1983). Of course, the publication of a policy does not necessarily reflect practice, for any State.

Yet another difference, directly following from the adoption or otherwise of a developed policy, relates to the range of computer equipment in schools. Indeed because of somewhat similar policies adopted by Tasmania, South Australia and Western Australia, these three States formed a consortium in 1982 called TASAWA. The benefits of a consortium were seen to be sharing information and, more especially, making software available to schools in each State on the same cost basis. Some indication of the range of computer equipment approved for schools in different States is evident from an examination of Table 1. The range may be even wider than Table 1 indicates because the non-government sector is not included since the varied nature of this sector makes it difficult to ascertain the kinds of computers in use.

Table 1. Microcomputers approved by State Education Departments

Approved Hardware	ACT	NSW	VIC	QLD	SA	WA	TAS	NT
Apple II/IIe	*	*	*	*	*		*	*
Atari		*						*
BBC		*		*	*	*	*	*
Commodore 64			*		*			*
IBM PC		*						
Microbee 16/K32K		*		*				
Microbee 64K		*				*		
Pulsar			*					
Tandy TRS 80				*				
Tandy Colour				*				

Source: Report of the National Advisory Committee on Computers in Schools (Commonwealth Schools Commission, 1983b), updated by recent announcements.

There are apparent differences, too, in the extent to which the purchase of equipment is subsidized or otherwise supported in different States. It is, however, difficult to make comparisons because the funding arrangements for schools differ from State to State.

An indication of the general rate of acquisition of microcomputers by schools is seen in the following figures from one State, namely, Queensland:

February 1981	: 160 schools	-	310 computers
February 1982	: 228 schools	-	643 computers
February 1983	: 420 schools	-	1,550 computers

Further quantitative information, obtained in a survey of all States and Territories, is reported in Brownell et al. (1982). Much of the information relating to numbers of pupils, schools and type of computer delivery is now dated, due to rapid developments that followed, but the results for programming languages and source of software are possibly less so. In courses where programming was taught, it is reported that the overwhelming majority used BASIC; in one State (Tasmania), Pascal was also widely used and there was some use of LOGO too. Three States (Tasmania, South Australia, Western Australia) are reported as developing the majority of software used by schools, while other States rely mostly on the equipment supplier, software companies or teacher-developed software.

Developments at the national level. Developments at the national level relating to computers in schools can be conveniently grouped into three. First, there is the role of subject and professional associations, together with government-sponsored information technology activities. Second, there are the meetings of the Australian Education Council and the Directors-General of Education, and meetings of schools computing personnel (leading to the TASAWA computing consortium). And third, there is the role of the Commonwealth Schools Commission.

Professional associations and information technology activities. A number of national conferences spanning more than a decade has provided some stimulus for educational computing. One of the earliest was in 1969 on the role of the computer in secondary schools, sponsored by the Australian Computer Society and the Australian Association of Mathematics Teachers. More recently, computer-user groups have promoted the cause of computer education, organizing seminars and conferences for teachers and teacher educators. Schools symposia are now also a regular feature of annual conferences of the Australian Computer Societ, 'ost professional subject associations, at least in 1984, included in their conferences a strand on educational technology, which for most meant a focus on microcomputers

Another important development that has done much to raise the community's understanding of information technologies is Information Technology Week. Such has been the success of these over the past five years that the Federal Government supported an Information Technology Month in 1984. Two important software packages were distributed free of charge to schools as part of these computer awareness activities.

TASAWA computing consortium. For the past several years meetings of the Directors-General of Education, as well as those of the Australian Education Council, have considered the question of computers in schools (Shears and Dale, 1983). One meeting of particular importance was the Conference of Directors-General in Perth (October 1982) which considered possible areas of national co-operation. The most vigorously debated issue was the agreement already entered into by Tasmania, South Australia and Western Australia to form a three-State computing consortium (TASAWA) to share all educational computing resources (Angle Park Computing Centre, 1982b). Several of the other participating States felt that the fait accompli presented problems on the grounds, first, that it pre-empted national co-operation; second, that there was a perceived unwillingness for other States to be allowed to join unless they could either provide software or make some financial contribution; and third, that TASAWA was seen as reluctant to agree to direction on the use of hardware, the development of software, or the provision of other services (Dale, 1982).

The Commonwealth Schools Commission. The Commonwealth Government has given some support in the past to computer education through several of its programmes (for example, the Schools Commission Innovations Programme, Projects of National Significance, Professional Development, and the Commonwealth Department Transition Education Programme) though none of these specifically related to computing. In its recommendations for 1984 (Commonwealth Schools Commission, 1983a), however, the Commonwealth Schools Commission concluded that large expenditure was urgent and necessary to overcome the serious deficiencies in current provisions for computer education. Among the Commission's recommended objectives were that schools should provide all students (Years 2-12) with at least 30 minutes hands-on experience per week, and that every school should have at least one teacher with sufficient competence to advise other teachers. To finance such a national programme, the Commission recommended that the Government should provide $125m* over a five-year period, that these funds should be directed to teacher professional development, to development of computer courseware and purchase of school and system level hardware. Such funding was to be in addition to that already provided by the States.

Support for the programme was promised by the major political parties but the final funding available fell well short of the original sought. Guidelines given by Government to the advisory committee set up to advise the Schools Commission also served as a constraint. Among these were that the programme should focus initially on secondary schools only, that some standardization of equipment and materials should be aimed for, and that, where possible, services should be shared between schools and sectors and

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Approximately Australian dollars 1.22 = One United States dollar across States. The committee's report contained 52 major recommendations relating to issues of curriculum development, professional development, software and courseware, support services, hardware, and evaluation.

Recommendations under curriculum development were that major priority be given, first, to computer awareness and computer literacy experiences for all students in the years of compulsory secondary schooling, second, to the integration of computing across the curriculum, and third, to the provision of optional computer studies courses at the senior secondary level. Professional development of teachers, particularly of women and of non-mathematics and non-science teachers, would be accorded high priority.

There was an emphasis in the recommendations on making available to teachers general purpose software word processing, spreadsheet and database tools. Programming languages to be supported should include Logo, BASIC and Pascal. Teachers should also be helped to develop their own courseware by providing such software development aids as graphics tablets, light pens and general utilities.

The preferred hardware, at least in the short term, was for the Apple II/IIe, BBC and Microbee 64K microcomputers. Clearly this was a contentious recommendation, with two committee members presenting dissenting opinions and arguing for a wider range of suppliers. States were encouraged to provide Support Centres to assist teachers from both government and non-government schools in the use of hardware and system software. There was seen to be an important role, too, for the Curriculum Development Centre in the schools computing area. Finally, it was recommended that a National Co-ordinating Committee should develop procedures for evaluating the Programme and for research and development activities.

Virtually all these recommendations were endorsed by the Schools Commission (the principal exception being the one relating to hardware, the Commission believing that different States should be free to approve microcomputers meeting their particular curriculum needs) and the Commonwealth Government in turn accepted the Schools Commission's advice.

Developments in computer use. Microcomputers are being used in Australian schools in a multitude of ways. School administrators are realizing that here is a powerful management tool and that many administrative tasks are similar to those in small businesses where the computer has proved an aid in inventory control, access to records, budgeting and accounting. Teacher-librarians are appreciating that the computer can be used to good effect in many aspects of library work. In the classroom computers are being used to teach programming, to teach about computers, to solve problems, to simulate processes to draw and design, to assist writing, to compose and play music, to access information bases, to drill facts, to test learning, to stimulate thinking, and to play games.

A distinction is often made between learning about computers, on the one hand, and learning with or from computers, on the other. A framework, then, that usefully distinguishes between the various categories of learning with or from computers is that of Taylor (1980) who suggested that all computing in education can be accommodated in one of three modes - tutor/tool/tutee. In the first mode, according to Taylor, the computer tutors the student; in the second, the computer serves as a tool, for teacher or student, having been programmed to carry out some useful task; and in the third, the computer is tutored by the student. Although any classification of computer use in schools must be arbitrary to some extent with categories inevitably overlapping, it was convenient in the wider review on which this report is based to augment Taylor's framework to embrace:

Learning about computers:

a) The computer as tutor;
b) The computer as tool; and
c) The computer as tutee

While it would be the exceptional school that could currently claim to use the computer in all these modes, nevertheless the descriptions given in Anderson (1984), based on practices in Australian schools using computer software developed for the most part in Australia, indicate the wide variety of ways computers are being used in Australian classrooms. If any generalizations can be made, one might be the realization on the part of software designers and developers, at least, that the computer as tool opens up many more possibilities for learning than, say, the computer as tutor. As well, teachers are beginning to explore the possibilities for learning under the mode computer as tutee.

Current activities of teaching institutions

It is more difficult to describe computing developments in teacher education within Australia because of the number and variety of institutions involved. Certainly there is no co-ordinated policy across institutions and, even within institutions, there is little evidence of a concerted and coherent approach to computer education. Overall impressions are, first, of patchy development for the country as a whole and, second, of schools of education generally lagging behind developments elsewhere.

Several universities offer first degrees or post-graduate diplomas in computing science though very few graduates from these courses enter teaching, such is the demand for computing graduates in industry. Nor is the course content geared to the school environment. A few colleges of advanced education offer graduate diploma courses in computer education that are more suitable for secondary teachers. Basic problems of all these courses are that computing is often seen principally as the preserve of mathematics and science departments and of secondary schools and, further, that the numbers graduating and entering teaching are too few to make much impact on schools computing in the short-term.

For the general classroom teacher, opportunities for continuing professional development are available through a number of avenues, especially for those teachers with an enthusiasm for and a commitment to computer education. In those States with a long involvement in the schools computing field, the respective schools computing centres offer many short, non-credit courses. These are popular with teachers and usually over-subscribed. Computer-user groups, professional associations, and computer companies also provide teachers with opportunities for first-hand experience and learning, often on specific microcomputers. These kinds of activities, however, are short-term in duration and they frequently attract those who already have some knowledge of computing and who, in addition, are often mathematics or science teachers.

The development of materials can fulfil a useful in-service function. The Angle Park Computing Centre in South Australia, for example, has developed a package of computer awareness teacher support materials which is becoming known throughout Australia. The package is designed for use at the secondary level (Years 9 and 10), though in some schools it is used at lower levels, and at others in Year 11 as part of an elective topic. According to Sandery (1982b), the materials were used in one year by approximately 16,000 students and 600 classroom teachers. Since the vast majority of these teachers had no special qualifications in computing, these teacher support materials serve an important professional development function.

Pre-service education, in the form of computer familiarization and the instructional uses of computers, is available through some universities and colleges of advanced education. Such topics, where they occur, are nearly always elective and constitute a very small part of the teaching qualification. A major problem faced by teacher education institutions, even if they wish to give greater emphasis to computer education, is that most academic staff are themselves unacquainted with the new technologies.

A potentially promising model for teacher education is provided by Tasmania where, perhaps because of its size, its commitment to the schools computing field, and available personnel, a co-operative venture has been established between University, College of Advanced Education and Department of Education. Called the Centre for the Continuing Education of Teachers (CCET), it offers a course on computers in education which is accredited by both the University and the College and is available for study in different regions of the State (McShane, 1983). The course is non-mathematical, requires no prior experience in computing, and appeals to large numbers of teachers, particularly primary teachers.

Signs that tertiary institutions are becoming more aware of the need to adapt their courses to take account of developments in computer technology are evident in the establishment of an Academic Advisory Panel on Computer Education in one State (Tertiary Education Authority of South Australia, 1983) and an enquiry into the future of academic computing within one University (University of Melbourne, 1983). Both reports recognize that the use of computers is growing rapidly and that there is a consequential need for greater resources for education in information technology. There is growing recognition, too, for all courses at the tertiary level, and particularly courses in teacher education, to include a component of computer education.

No mention has been made above to the research activities of universities in the educational applications of new information technologies which, according to a survey by the Centre for Educational Research and Innovation (OECD, 1984), are healthy and diverse. It is also proposed to set up in Australia a research centre for the study of computer applications in educaton involving several universities and the Commonwealth Scientific and Industrial Research Organization.

CHINA

General development of computers

In face of the challenge of the new technical revolution, the Chinese government has decided to concentrate forces on the development of computers and building up of computer manufacture and information service systems. Enthusiasm is shown throughout the country for the application of computers, especially microcomputers.

Computers first appeared in China 28 years ago. In recent years since the adoption of an open foreign policy and a more flexible policy at home, the computer industry in China has been developing soundly in research, manufacture, application, and training. A complete computer service system is taking shape. Computer enterprises, both under central and local governments, pool together their resources and absorb funds in various ways. They are quite flexible in seeking foreign funds and co-operation. It is the same with the network of computer technical services in which the states, collective and individual, all play their role in the development of software and computer systems, and in offering technical services. The Bureau for the Management of Computer Industry under the Ministry of Electronic Industry exercises leadership over the computer industry.

Under a general plan made by the ministries concerned, and with the participation of technical service companies, colleges and other research institutions, a great network for training personnel and popularizing the application of computers is being built up.

The government pursues a policy of developing microcomputers and giving priority to their application. It was revealed recently that microcomputers will be made in northern, eastern and southern China during the Seventh Five-Year Plan (1986-1990). The intention is to establish a network comprising scientific research, production, application and development, sales, service, and training before 1990. It is proposed to use computers, and especially microcomputers in realizing automatic control of production, project designing and economy management; building up an economic information system; and raising the efficiency of office work. The aim in the application of computers by 1990 is the popularization in big enterprises and colleges, as well as in some selected key enterprises of medium size, research institutions and institutions of economy management; to equip some small enterprises, middle schools and commercial departments of management with certain computers; and try the applic. ion in some local village enterprises and primary schools. In recent months, computer software companies have been set up in ten provinces and municipalities. Other regions are considering establishing similar ventures.

<u>Computers in general education and computer-assisted instruction (CAI).</u> Computer education in middle schools is at the initial stage, but it is developing rapidly. In 1978, some youngsters at Shanghai Children's Science Centre first received some basic training in computers. In 1980, a few microcomputers were presented to Jingshan Middle School in Beijing by Beijing Council of Science and Technology. The students started to learn how to use the computers during their spare time. In 1982, at the request of the Ministry of Education, Beijing University and two other colleges helped the middle schools attached to them in starting courses on computers. In 1983 the Huaxia Fund contributed

computers to the equipment of some key schools from six cities and provinces including Beijing, Shanghai and Hubei Province. The Ministry saw that teachers were trained for these schools. Computer education thus started in middle schools.

At the initiative of the government and the Ministry, and with the support of various enterprises and individuals, more schools started computer education in 1983. The number reached 250, with 2,000 computers and microcomputers at the beginning of 1984. In the area of Beijing alone, there are 60 such middle schools with more than 300 microcomputers. With computers in a few primary schools, computer education is really starting.

As a developing country, China is not capable of investing heavily in computer education. The funds for computers in middle schools and primary schools mainly come from government appropriation; donations from colleges, research institutions and enterprises, and donations from overseas Chinese and friendly countries. With the help of some universities, research institutions and enterprises, many short-term training courses are offered in computer education. As a result, a number of capable students are being produced. At present, computer courses in middle schools are mostly optional in Senior I and II, with an allowance of 45-60 class hours per term. In some junior schools, the students receive computer education in such an informal way as part of their extra-curricula activities. The aim of computer education in middle schools is to provide the students with some basic principles of electronic computers, fundamental knowledge of BASIC language and the role computers play in human society. Great importance is attached to the development of the students' intelligence and logical thinking, and problem-solving.

The Ministry of Education started computer education in primary schools in 1984 in Beijing and more than 30 other large and medium-sized cities.

These are pilot schools and 300 microcomputers were provided. Moreover, some primary schools also received aid from local governments and enterprises. The training in computer science at primary level, however, is undertaken mainly as part of extracurricular activities, through which the school children are expected to have some fundamental knowledge of the computer and the BASIC language, be able to work out the simplest programs, and to run programs. Computers have been heralded as an effective way of developing the children's intelligence and their creative and logical thinking.

To push this trial forward, a nationwide juvenile computer programming competition, sponsored by the China Association for Science and Technology and the Ministry of Education, was held early in 1984. Eight thousand students from 25 provinces, municipalities and autonomous regions participated, the youngest being only 12 years old. The 53 students entering the finals had an experience in computers from only two months to a year but they received high praise for their marvellous programming. This competition has met with general approval and will inevitably give a boost to computer education in elementary and secondary schools.

Application of computers in education. How to use computers in education is something new in China since computer education has just started. As for CAI, some teachers are trying it out in various ways. Some schools are trying to develop courseware which could be used in the teaching of mathematics, physics, chemistry or geography. For instance, in the youngsters' competion mentioned above, some students worked out a program which could be used in teaching geography.

As for computer managed instruction (CMI), re earch is being made on school management and filing books and other materials.

Trends of development. The main difficulties in developing computer education and adopting modern technology in education are (a) shortage of funds; (b) shortage of qualified teachers and management personnel; and (c) lack of experience. The Ministry of Education has adopted positive measures in expanding the scale of experiments in computer education in a planned way.

Since the price of microcomputers is falling, and the government and society are more concerned about school education, computer education will be expanded rapidly from key schools to ordinary schools in cities and then to the schools in the rural areas.

Another trend is that the use of computers will occupy an increasingly important place in education. On the one hand, universities and colleges will produce highly qualified teachers and experts. On the other hand, the Ministry of Education is thinking about offering in-service training to teachers of both middle schools and primary schools, in order to lay a foundation for CAI and the use of computers in school management.

Tasks for research institutions

The development of computer education and new educational techniques have set new tasks for educational authorities, educational research institutions, as well as educational colleges and teacher's colleges.

Teacher training. The Ministry of Education has made it a rule that the teachers of CAI have to undergo special training and earn certificates issued by the relevant departments. A teacher training base is formed by educational colleges, universities and computer education experimental centres, which are now engaged in teaching program development and teaching material compilation.

Study of the new problems. The fact that computer education is becoming an inseparable part of education as a whole and is playing an important part in the development of the students' intelligence brings about some new problems to the teachers and research workers: What is the effect of computer education on the development of students' intelligence? What is the relationship between computer education and other subjects such as physics, chemistry, mathematics and biology? What is the optimum age for a student to begin the study of computers? And how will the computer play its role in teaching? Computer education is closely related to the reform of the educational system, the teaching content and man's ideology.

Also taken into consideration are these questions: What are the demands of modernization upon education in the development of skilled manpower? What should a middle school student be like in the future society? What should be done to fill in the gap between education and the new technical revolution? Chinese educators are now trying to answer these questions concerning the reformation of education.

INDIA

Development of computer education

In a developing country like India there is a perpetual need to adapt emerging areas of technology to inform, to provide skills and to educate the people to enable them to realize their full potential and contribute towards national development. In order to keep pace with the wide and far-reaching changes in technology, it is felt necessary to use high technology for education as well. The Sixth Five-Year Plan document recognized the importance of educational technology, and states:

> The importance of educational technology has to be adequately provided for greater efficiency and effectiveness and wider reach of the educational programmes.

It is recognized that there is a great need to expose today's children to the nature and uses of computers, and to make them capable of coping with the present and future technological environment. In the firm belief that computer literacy has to be an integral part of every child's education, the government has launched a computer literacy programme, Computer Literacy and Studies in Schools (CLASS), in 250 schools distributed throughout the country.

Status of computer usage. Data processing for business has been accepted both by companies (large and small) and labour organizations. More than 1,000 systems have been installed, and the rate of growth is expected to be about 1,500 every year. The availability of hardware is no longer a problem, but there is an acute shortage of trained manpower. Research in the country has become computer oriented, and agencies for administering education are constantly making efforts to provide funds for setting up or modernizing computer facilities in educational institutions. Steps are being taken to establish public data networks to facilitate information exchange and also to provide remote access to specialized hardware and software. Engineering design has been computerized to some degree and a lot of social science research is also computerized.

Indigenous computer industry. Computers have been in use in India for data processing and research application for more than 25 years. Indigenous manufacture started in the country with the establishment of the state-owned Electronics Corporation of India (ECIL) about 20 years ago. ECIL designed and built 12-bit and 16-bit computers and has recently started marketing a 32-bit medium scale computer system. Presently, there are two firms producing the TDC 332 and ICL 2904 series in the medium range of computers. To meet the requirements of midi/maxi range of computers, the government is now in the process of importing technology for their manufacture.

In the area of microprocessors/minicomputers, industrial approval has been given to about 150 firms of which 50 have started production. Most of these firms cater to the commercial data processing segment and are producing accounting/invoicing systems, data-entry systems, word processing systems, general purpose EDP and scientific systems with limited capabilities. However, there is not much orientation of the industry towards specialized application areas such as computer-aided design/CAM, CAI, dedicated industrial and process control, information management systems or on-time transaction oriented operations, for which the country is still dependant on imports. In the field of computer peripherals, about 60 firms have been approved for manufacture, of whom 13 have started production. These firms are presently making video display terminals, floppy disc drives and card readers. Not much headway has been made in the manufacture of other peripherals where high investments are required on tooling, production and test equipment.

The major emphasis today in the development of the minicomputer/microprocessor industry is on the setting up of system engineering companies which are not necessarily engaged in the manufacture of central processing units (CPU) and peripherals. To assist the development of programs for the system engineering of minicomputers, the industrial capacity for the production of a standardized range of peripherals and CPUs would be built up on an original equipment manufacturer (OEM) basis, so that there is free indigenous availability at reasonable prices of the basic building blocks for microcomputer/ microprocessor systems.

Manpower availability. There is an acute shortage of trained manpower in the area of computers. Reasons are that the growth in requirements has outpaced the capacity to increase training programmes. Whereas business opportunities which require manpower grow overnight, the establishment of academic/training programmes takes time and they are resource constrained. Many programmes to generate desired manpower on a short-term basis have been launched. However, these efforts have been hampered by the shortage of trained teaching manpower.

Training programmes in the area of computer technology and application. Four-year Bachelor Degree programmes in Computer Science and Engineering are presently available in 22 engineering colleges. Twelve institutions have started Master's level (M Tech) programmes in Computer Science and

Engineering. On the recommendation of a manpower committee appointed by the Department of Electronics, a 3-year Master's Programme in Computer Application (MCA) has been started in 14 institutions. One-year to one and a half years Diploma Programmes in computer applications (DCA) after B Sc level are now available in 15 universities, and similar courses are also being offered in 16 polytechnics. Training programmes for console operators (one-year duration), and data preparation assistants (six months), are offered in Industrial Training Institutes. There is, however, a great demand for these programmes and short-duration training programmes are also organized by many commercial establishments.

Professional societies. India has a very active professional society called the Computer Society of India which has more than 6,000 members. Their chapters are organizing training programmes to train new people, update members and conduct tests to certify competence.

Export of computer based services. India has a well-established sector for providing high quality professional services to design and develop custom applications in other countries. Software exports amounted to Rs.130 million* in 1983, and are poised for high growth.

Present trends in the use of computers in education

Computer courses have been integrated into engineering education in the country. In addition, specialized manpower developed programmes like B Tech and M Tech courses in FORTRAN programming and numerical analysis, are taken by all engineering graduates. However, there is little use of computers in enriching teaching and they are largely used as a tool (super calculators) or to teach some form of

* Approximately Indian Rupees (Rs) 12.55 = One United States dollar.

computer science. The potential of the computer to modernize the education process itself is yet to be recognized. However, there are instances of use of CAI. Some research in developing CAI systems has also been undertaken. The use of computers in educational management is limited, and largely confined to processing of admission and examination results.

The CLASS project. Under the national pilot project CLASS, computers are being introduced at secondary and higher secondary schools as a teaching/learning tool, to build up awareness and as a support to the curriculum. The project is a collaborative effort of the Department of Electronics and the Ministry of Education. The National Council of Educational Research and Training (NCERT) which is the apex body engaged in research, development, training and extension programmes in all areas of school education is the National Co-ordinating Centre for the CLASS project, and also one of the 42 Regional Resource Centres which have taken up the responsibility for implementing the project. Microcomputers have been selected for this programme because of their low cost, and the availability of software packages such as word processors, data-based systems and computer-based learning packages suitable for the school curriculum. The pilot project has been launched to:

a) provide students with a broad understanding of computers and their use;

b) familiarize the students with the range of computer applications in all walks of human activity and the computer's potential as a controlling and information processing tool;

c) demystify computers and develop a degree of ease and familiarity with computers which would be conducive to developing individual creativity in identifying and developing applications relevant to their immediate environment; and

d) encourage teachers to use the technology in improving effectiveness of their teaching.

Initially 250 schools have been selected from the 55,000 secondary and higher secondary schools in India. The participating schools have been drawn from a national network of schools belonging to Kendriya Vidyalaya Sangathan, Government Schools affiliated to the Central and State Boards of Secondary Education, and some private schools.

It has been realized from the beginning that the success of the project would largely depend on the quality of teacher training, the back-up support to the participating schools and the mechanism for monitoring and evaluation. Forty-two resource centres for the project were selected from amongst Universities and engineering institutions in the country involved in computer education. In the selection of participating schools, care has been taken to ensure that the schools are located within a 50km radius of the resource centres. The important functions of the resource centres are:

a) support/consultancy assistance to teachers of selected schools;

b) monitoring the implementation of the programme with a view to particularly identifying problems and their solutions;

c) training of teachers of schools covered both in experimental phase and the wider expansion phase;

d) maintenance of computers and attending to some urgent replacement of parts for which purpose the resource centres would have to maintain spares;

e) interaction among themselves and also with other educational training institutions;

f) development of curriculum and teaching strategies; and strategies; and

g) promotional activity with a view to popularizing the programme.

Maintenance and service support for the project has been organized through the Computer Maintenance Corporation, a Government undertaking. As the computer systems would be located at different places throughout the country, it would not be cost effective to organize maintenance services at the user's location. Therefore, additional systems would be kept at resource centres; and educational institutions would be enabled to exchange defective systems for working ones. Maintenance by replacement would minimize interruptions in the educational programme and enable optional utilization of manpower.

Although the schools selected under the pilot project do not generally follow the same curriculum or the medium of instruction, at the initial stage a common course of studies for teachers and that for students has been adopted for the project CLASS. While designing a curriculum for computer literacy and studies, it was appreciated that the need for learning programming languages for using microcomputers in day-to-day life has more or less disappeared. Therefore, the curriculum is based mainly on problem solving activities through the use of generic software packages which involve considerable programme-like activities.

Seven hundred and fifty teachers (three from each of the 250 participating schools) were trained through intensive three-weeks long teacher-training courses which were simultaneously conducted by 17 of the 42 resource centres during June and July 1984.

Concerns in the implementation/extension of the programmme. There is always concern about the 'gap' between the urban and the rural child. The 'gap' sought to be reduced through development programmes may however, be further accentuated by non-availability of computers, because the urban child will have opportunities to work with computers and hence will prove more useful to an employer. Thus, it is not a question of considering use of computers in rural schools as desirable, but as necessary if one wants to protect the rural child against serious disadvantage.

India must meet its need for school computers through indigenous development, and not rely on imports. Steps have been taken to manufacture necessary micro-chips within the country. Sources for low-cost rugged peripherals also need to be developed.

Teacher training will perhaps be more difficult than the indigenous manufacture of systems. If three teachers have to be trained in each school, the training of 180,000 teachers for secondary schools, let alone the 750,000 primary schools, will be a mammoth exercise. Methods have to be evolved to accelerate the training process and train large numbers at a time using mass-media. This training has also to be included in the syllabuses of teacher training courses (Certificate and Graduate) to avoid the retraining of new recruits.

Maintenance of these systems could be a problem. Some teachers must be imparted rudimentary training in maintenance essentials and repair centres set up for bringing in faulty systems. A great deal of standardization (at least area-wise) will be required.

Teaching material and lectures in local language would have to be prepared, and suitable interfaces devised to adapt computer software to that language. With more than 16 distinct languages in India, this requires a very systematic approach.

Whereas teachers could handle packages, all of them may not fully succeed in putting across essential concepts to the children. Mass media like TV would have to be utilized to augment the teaching effort.

In a country like India which has to use its scarce resources efficiently, it is very important that resources yield commensurate benefits. It is necessary to design appropriate evaluation techniques to establish guidelines for future extension of the programme.

Since there will be schools which cannot justify installation of computers year round, mobile vans with computers, teachers and VCR can be provided to go around several schools during the academic session.

Affordable computers have given new hope to the handicapped of leading a productive life. Appropriate hardware interfaces and software need to be developed to meet the requirements of physically handicapped or retarded children.

Current and future trends in educational technology

The current emphasis in the use of computers in schools is on enriching the teaching process through computer based learning (CBL) packages rather than replacing a teacher by a computer or development of automated teacher.

At the school level, the classroom should be teacher centred, and teaching aids such as the computer must reinforce the position of the teacher and enhance his/her capability. A computer must help the teacher to increase the learning efficiency and creativity of a child using techniques which are not otherwise possible. Currently, selected teachers are being exposed to select CBL packages from outside India so that they can suggest the specifications of a new generation of CBL packages tailored to the Indian context. Computer science groups in leading engineering institutions are working on the following:

a) Development of low cost, rugged (tropicalized) computer hardware, particularly regarding

b) Develop a processing capability in Indian languages and associated alphameric and graphic display software;

c) Adapt certain generic packages like spread-sheet, data base to Indian languages; and

d) Development of audio-visual software and other teaching material for training teachers and for direct use in the classroom.

To develop CPL packages, themes and scripts would have to be evolved by creative teachers. Availability of software tools would facilitate a teacher experimenting with graphics and animation.

The future work should include:

a) Development of prototype development tools particularly for graphics;

b) Tools to incorporate 'HELP' features to make packages self-instructional;

c) A CBL package developed in high-level language to be automatically converted (compiled) into the particular machine on which it has to run;

d) Integration of audio-visual a[illegible] such as audio tapes/video tapes and slides [illegible]h CBL packages;

e) Development of facilities for capture of software directly from broadcast on the lines of 'CEEFAX' technique to afford easy dissemination and error-free replication; and

f) Use of school computers in laboratory and robotics to illustrate control application of computers.

JAPAN

Primary education and the new information technologies

Examples of the application of CAI in education at the primary and lower secondary levels are rather rare in Japan. Recent trends are that in elementary schools it is used mainly for drills in arithmetic or science; in lower secondary schools mainly for tutorial modes in mathematics or science; and in upper secondary schools mainly for understanding scientific concepts (physics, in particular) and for doing calculations (tutorials utilizing card formats). The microcomputer-based graphics simulation mode is also used. In universities CAI is used in scientific and technical instruction, management and simulation and gaming modes. It is also used as "assisted instruction", with systems for information science curricula consultation or document preparation. Supplementary texts are used.

Elementary and lower secondary education is, compared to other countries, relatively unified in content, system and structure. Conditions for introducing LOGO or similar systems into the current curriculum are actually not favourable. For this reason there are no examples in public education. It is felt that pressures to develop student creativity will produce a need for these systems in the future, but at the same time a variety of administrative problems would be anticipated.

One system now in operation, however, is a "Practical Environmental System" for mentally retarded children which has been developed by the Ibaragi University, Faculty of Education.

Education. Although a number of system and/or courseware evaluations have been conducted, no overall assessments have been made by any specific organizations. Major findings are as follows:

a) The use of Kanji* combined with Kana in Japan creates a number of hardware and software input problems. Many of these problems exist because of the fact that for CAI in Japan there is nothing equivalent to the way Europeans and Americans use typewriters as a normal part of their daily activities.

b) Pattern matching is very common in processing and analysing response statements. This is very likely related to (a) above and makes it difficult to develop any kind of CAI language recognition system.

c) Because of the situation outlined in (b) above, it is easy for error statement processing and corrective guidance data display to become mechanical. Furthermore, detailed courseware storage greatly increases the amount of work required in its preparation and reduces cost/performance ratios.

d) It is difficult to develop techniques for preparing courseware. In other words, the relationships between the instructional materials and learner abilities and other individual differences are not always introduced in a clearly understood context.

e) Much of the CAI material prepared in the past has been based upon operant theory. However, programming techniques based upon the antithesis,

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*'Kanji' are the Chinese-Japanese characters or ideographs, while 'Kana' includes both Japanese syllabaries -- 'Hiragana' (cursive) and 'Katakana (block).

cognitive theory, have become popular topics of investigation. For this reason CAI does not always present a truly representative model.

f) Although cognitive-based CAI is gradually being developed, it is being done at the university level and opinions on assessment are very fluid.

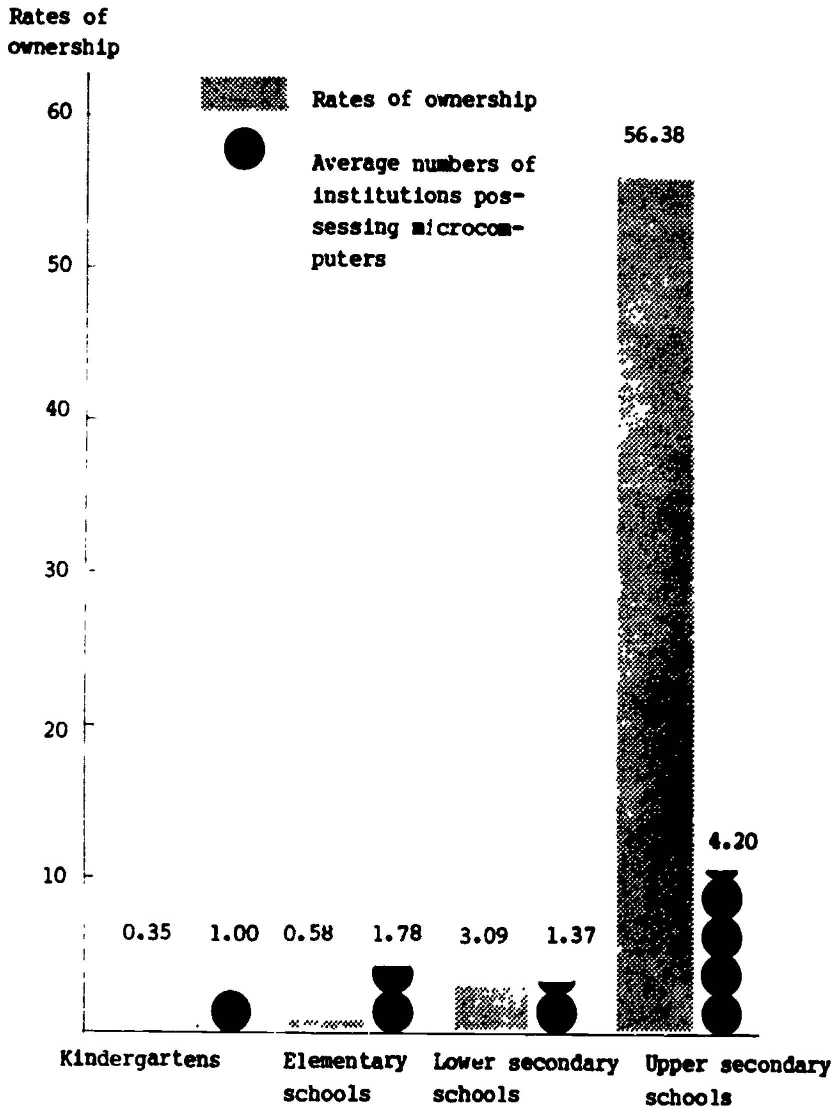
g) Generally, however, it can be said that there have already been a number of reports showing that courseware prepared for the purpose of developing basic scholastic abilities can be effective.

Equipment. At present there are very few practical systems in existence; probably fewer than 0.1 per cent of the schools have anything at all. It is felt, however, that this situation will change rapidly in the near future as a result of the diffusion of microcomputers and stand-alone CAI. The equipment that is available has been financed by the Ministry of Education and local (prefectural and municipal) governments.

Reasons for introducing CAI. The primary reasons for introducing CAI have been to offer students an individualized learning environment and to develop a means for coping with individual differences. These, however, are not the same as the goals for individualized instruction seen in Europe and America (elimination of differences in culture, languages and wealth, and even for distance education). Within the Japanese climate of a single people and a single language, and even more, a relatively unified educational system and curriculum, the emphasis is more likely to be upon ensuring the scholastic abilities of slow learners and levelling out differences in educational progress. A second aim is that it is possible through CAI to help teachers acquire and improve lesson plan development skills.

Systems development is conducted primarily by companies and universities. Administration and

Institutional ownership of microcomputers



management on the other hand, is handled by local educational organizations (elementary or lower secondary schools). However, technical support is frequently furnished at the university level.

Courseware development is conducted primarily by local school and university teachers.

Languages used in material preparation. A standardized CAI language for use in Japan was developed during the very early days of the movement and has been a major influence in the development of CAI ever since. It was designed so that the major commands could be displayed at the terminal, and program logic could be developed frame by frame.

The language is not very powerful in comparison to CAI dependent languages such as ELIZA or TUTOR. Thanks to the influence of microcomputers, however, BASIC is now being seen as a data-base system and APL and other languages are beginning to be used.

Management of materials. Most CAI materials are stored on magnetic tape or disks, or floppy disks. However there is still no system for nationwide documentation which has taken such things as ease of management and exchangeability into consideration.

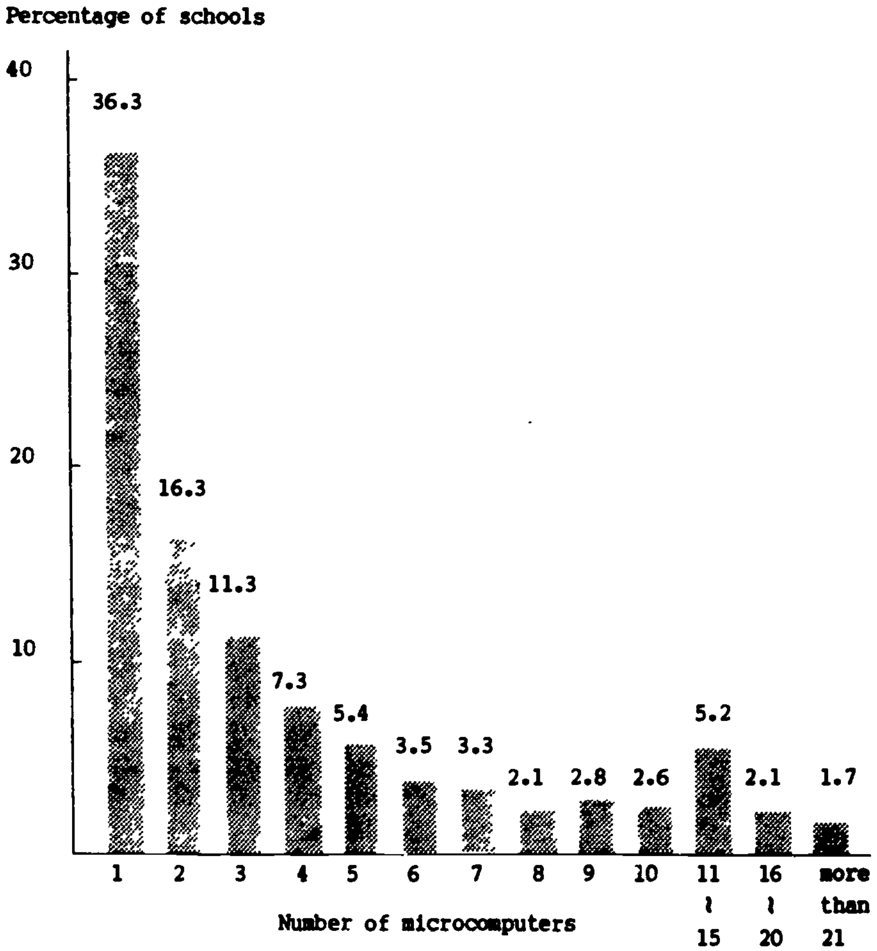
Student feelings of participation. Beginning motivation is usually a result of curiosity, however there are a number of problems arising from defects in interactive adaptability which, in turn, result from weaknesses in man/machine interfacing. Users are often dissatisfied by the lack of an adequate number of clearly defined computer responses to errors. However, at a minimum, they are generally favourable due to the fact that these systems do offer self-paced, individualized learning environments.

Teacher feelings of participation. Few teachers are involved in CAI if for no other reason than few systems or terminals are available. However those teachers who are interested are positive in their approach to development and experimental courses and programmes. There is also a Hawthorne effect among those teachers who are participating in various joint university projects and most of them participate very willingly. Generally speaking, however, due to the emphasis which is placed upon the human teacher-student bonds within the educational setting there is an allergy to computers. Even more, many people feel that educational effectiveness is not just short-term learning effects but involves the development of the entire personality.

Relationship to the regular curriculum. CAI research and development began in the mid-1960s and remained basically experimental in nature until about the mid-1970s. While various experimental programmes were developed during this period, few of them were brought to the stage of becoming a part of the regular curriculum. This was because costs were prohibitive and systems existed within only four or five research centres. There was absolutely nothing in public education facilities during this period.

Although still experimental in nature, from around the mid-1970s several systems were introduced into a few lower elementary schools and some CAI programmes (primarily in mathematics) were incorporated into the regular curriculum. This, however, did not mean that CAI was being systematically incorporated into any specific courses of study. This trend is still much in evidence even today; in many instances CAI is incorporated only as a part of a course of study (primarily arithmetic, mathematics or science) within the academic year's overall schedule. However, even within these limited areas, emphasis is still upon "teacher-CAI-pupil interaction". Also, many CAI projects have been relegated to the after-class, self-study or supplementary-study ghetto.

Numbers and percentages of microcomputers held by upper secondary schools



Prediction on CAI trends and technology. It is felt that as a result of the current rapid diffusion of microcomputers, CAI will soon begin to infiltrate the regular public school system. There are, however, problems related to the development of new organizations and curricula needed for management and administration of CAI. At the same time there is a drastic need for reorganization of the teacher training curriculum. Teacher education and training shows little change. For the foreseeable future most likely only fragmentary diffusion based upon research and experimentation by just a small, select group of teachers will be seen.

In privately-run elementary and lower secondary schools as well as the so-called juku* and other educational enterprises and home education, it is felt that CAI will soon spread rapidly. One reason is that most of these institutions are clearly aiming at society's educational goals. Furthermore, these sectors of the educational establishment are able to train, without worry of interference, and have the personnel and staff they need in order to adopt and administer CAI. For these and other reasons it is felt that these sections of the educational establishment should be able to quickly and successfully incorporate CAI.

Without any doubt, the use of microcomputer-based CAI will increase concurrently with the continued lowering of microcomputer costs. In 1983 it was possible to request delivery of a standard 8-bit microcomputer for around Y200,000.

* 'Juku' are privately-organized evening and weekend schools attended by many students in Japan. Ages range from the fourth grade of elementary school through the end of upper secondary education. They aim at helping these students pass entrance examinations.

Within the next five years it should be possible to connect stand-alone microcomputers to local networks thereby permitting mutual utilization of materials (CAI courseware). Also, while still at the experimental stage, if hardware reliability can be improved and costs further reduced, microcomputers should begin to move into the ordinary classroom.

The problem of Kanji. Resolving the problem of processing Kanji is an important prerequisite to the improvement of conditions for the diffusion of CAI in Japan. This problem is beginning to be resolved at the output level but input difficulties still remain.

Japan has never developed the "typewriter" habit that exists within the European-American cultural sphere; handwritten messages are still a common day-to-day means of communication. Because of this, a realistic solution must await improvements in techniques for computer-recognition of handwritten patterns. Even more, at the lower levels of elementary schooling there is still a heavy emphasis upon learning to write. This means that it is also necessary to wait for a highly accurate handwritten character-recognition device. There is a great deal of competition inthis area among researchers working on pattern recognition both in industry and in university faculties of technology. From the above, it can be readily seen that man/machine interfacing is a particularly serious problem.

Voice recognition. Thanks to developments based upon advances in music synthesizers and other technologies, techniques for inputting written Japanese (romanized and/or kana) and outputting a recognizeable "voice" are gradually being perfected. However, it will probably be some time before human voice recognition techniques can be put to practical use.

Media. Magnetic tape, disks, floppy diskettes and cassette tapes are the primary CAI material storage media in use today, although most likely video disks will come to be used in the near future. For the latter, however, high production costs and the fact that it is impossible to correct (i.e., rewrite) programs are both serious problems which must be resolved before full use can come about

Data transmission. Systematic development, maintenance, management and co-operative utilization of instructional material databases are very importent to the effective use of CAI. One type of network visualized for Japan is to first connect a host computer installed at an instructional materials centre to regional centres for educational technology, then to further connect these regional centres to local networks which would handle the actual delivery of the CAI programs. End-use stations would include a TSS terminal, microcomputer, and facsimile equipment. Materials developed at any one terminal (assuming, of course, the existence of a standardized language) could be sent through the regional centres to the main instructional materials centre for storage and later called up by other terminals.

Software. The language is possibly the most important factor in preparing CAI software. A standard CAI language was proposed in Japan in the 1970s and has been used by nearly all early CAI systems. This language was designed so that the average teacher could easily use it. Its grammar and command content are therefore rather simple. This means, however, that it is difficult to use in development of flexible and dynamic software. Unfortunately, no replacement language seems to be under development at this time; the focus is on using standard computer languages instead. One result of the rapid diffusion of microcomputers over the past few years has been to use BASIC for software development. BASIC, with its greatly strengthened capacity to handle graphics, is now considered as extremely suitable for simulation material development.

In developing CAI programs, it is also possible, to use highly structured languages (such as APL) to define the commands. From a systems standpoint and premised upon actual utilization, it is still important that some kind of tool be available which will make it easier to prepare materials.

Artificial intelligence CAI. While there are still no examples of true artificial intelligence CAI, a number of research projects are underway in various Japanese universities. A great more will be expected from this field as 16-bit and 32-bit microcomputers are developed and practical operating systems become available. Most likely, however, the trend will be for these to be used at the university rather than at the primary or lower secondary school levels. Also, much is hoped from intelligent CAI because several artificial intelligence languages such as Lisp, Prolog, Ada, C, and others are now being adapted to microcomputers. However, a number of technical problems must be overcome before these hopes can be realized. These problems include an "in Japanese" language system (theories for analysing sentence structures and meanings, and construction of parser models, terms and forms), a document generation system, a rational production system, and so on. A brief review of these requirements quickly shows that it will be difficult to put these systems into use at elementary and lower secondary school levels for some time to come. It is more likely that before that happens there will be wider diffusion of effective material production, revision and storage techniques based upon already available frame model retrieval techniques and CAI data bases.

As can be seen from the above trends, it is felt that there is a need to develop arrangements for distribution and mutual utilization of CAI, particularly in relation to content (instructional objectives, study unit content, evaluation, learning modes), and for standardization of storage formats and development of a metalanguage for courseware production.

There is also a strong need to rapidly develop teacher training curricula on computer literacy, systems application and management skills and material production techniques. The courses of study as outlined by the Standards for Teacher Certification in Japan are rather outdated. They have not kept up with the times and are seemingly premised upon a philosophy of "just the same as before". As a result they meet neither the needs of the era nor those of the society. Hopefully, however, positive and concrete steps in correcting this situation will be taken in the near future.

PHILIPPINES

Background

More than 20 years ago, the very first "modern day" computer was installed in the Philippines. This event marked the start of computer awareness. According to the Philippine Computer Industry Study conducted by the Philippine Computer Society, the computer industry is large and growing. The National Computer Center (NCC), in plotting the growth of the number of computer systems from 1963-1980, has shown that the growth rate averaged 44.4 per cent annually for the 17 year period and 29.5 per cent annually for the decade 1971-1980. The figures show that 327 systems had been installed in the country by 1980. Of this figure, 260 or 79.7 per cent were in the private sector while 67 or 20.5 per cent were in the public sector.

The studies regarding the state of the art of the computer industry indicate that there has been no manufacturing component except in the semiconductor manufacturing sector which has provided a big portion of the export component of the country's trade and industry.

With respect to hardware and software manufacturing, there has been no activity. However there is a trend in the provision of services through manpower export ranging from the managerial level to data entry operators. This gives an indication of the kind of manpower needed by the country and will provide a significant input to the computer education direction of the country.

Government policy directions. Government interest in the computer industry has prompted the lifting of restrictions on acquisition of computers below two million pesos by removing the need to get a clearance from the National Computer Center for private sector and government. A committee has been formed to review the role and potential of computers in the development of the economy, consistent with the framework of the Philippine Development Plan and to make the necessary recommendations and a plan of action.

Development of computer education

Although computer education had a slow take off in the 1960s and 1970s, the present decade shows a significant growth in school computer courses and degree programmes. Presently, there are 15 universities offering computer specialist programmes at the bachelors level throughout the country.

Computer courses in the professional areas such as Engineering and Commerce have been added to their respective curricula with the Accounting majors having the most computer courses numbering about 21 units. Thus, computer applications in different professions are being studied.

The Ministry of Education, Culture and Sports uses a recommended minimum standard curriculum for the B S Information and Computer Science and B S Computer Engineering. These curricula have been developed through the co-operative efforts of the academy, industry and the Ministry.

Another significant development in computer education is the inclusion of a three-unit course in computer in the general education curriculum. Entitled "Computers and Society", this course is to be required of all students from different degree programmes including Liberal Arts. Having a much lighter technical component, the course includes social implications of computing in day-to-day living as well as the philosophical considerations.

A major consideration in implementing any computer education programme is the availability of teachers. In this area, the Philippines has recognized the need for this so that a nationwide training programme has been organized. Certain organizations, such as De La Salle University, have for the past two years been providing training to teachers from different schools in co-operation with the Philippine Association of Colleges and Schools of Business and the Ministry of Education, Culture and Sports. A long-term effort, this programme has solicited the support of the Philippine Computer Society which has created a committee to help the Ministry and the different universities in the country which are in a position to help provide teacher training courses in computers.

Computer education for elementary and secondary levels. There are no plans for other levels of computer education such as elementary and secondary. MEC has started discussions regarding this matter, but no formal intervention has been set.

Some training centres have started to offer computer training for children and it is estimated that about 2,500 students have attended such courses. The age range of children studying computers is 5-15 years, the majority taking computer courses only during summer.

Several schools have utilized computers for their information systems. Applications using computers are in accounting, student records and personnel information, among others. The types of computers used range from microcomputers to big mainframes.

Computer education at De La Salle University. One of the leading institutions for computer education, DLSU has been offering computer courses since the late 1960s. The university started to revise its curricular offerings to include computer literacy courses in Engineering, Science and Commerce in 1975.

Later, its computer literacy programme was extended to all degree offerings including Liberal Arts with the inclusion of a computer fundamentals course with BASIC programming.

In 1981, DLSU offered the country's first Bachelor of Science in Computer Science programme. The following year, the programme, Master in Business Administration started to offer a major in Computer System Management in order to train future data processing managers.The Master in Science Teaching major in Computer Science was started in 1984 in order to answer the country's need for qualified teachers in the computer specialist programmes. An M S in Computer Science will be offered in 1985 to accommodate the needs of the coming graduates of the undergraduate Computer Science programme.

One of the major thrusts of DLSU is computer education. Thus, it continuously upgrades its computer facilities which currently include three minicomputers with 45 terminals, 80 microcomputers and several training kits in computer system organization.

Summary

Computer education in the Philippines accelerated in the 1980s as can be seen by the increase in the curricular offerings of schools for computer courses. Computer literacy, computer fluency and computer specialists programmes in education are being addressed. However, there is a need to define the directions of computer education with respect to the thrusts that the different schools should take.

SRI LANKA

Status of technology

Although a very long tradition of open and free access to learning for both males and females has given Sri Lanka a literacy rate of 90 per cent and an equally high primary school participation rate, equality of educational opportunity from the point of view of access to well equipped schools, still remains a long-term goal. Only 10 per cent of the schools have electric power, and about the same number have workshops. The majority of the schools are not even exposed to the gadgetry of modern educational technology.

Until 1977 the gadgetry available, even in the largest offices was confined to typewriters duplicating machines, adding machines, cash registers and intercom telephones. A few large organizations had main frame computers equipped mainly for batch-processing. Sri Lanka was also one of the few countries which had no television broadcasting. With the adoption of an open economy with a free-trade policy and the removal of very restrictive import regulations, modern office equipment began making a mark in Sri Lanka. TV broadcasting began in 1979 and simple electronic calculators, which were a rarity, came to be widely used in commerce and in the home. Sri Lanka thus began adopting the use of modern equipment based on the electronic revolution somewhat late. In some cases it was advantageous because there was no obsolete technology to replace!

Educational technology in schools. The adoption of modern office technology began creating a demand for jobs in the relevant fields. While good general education standards made it easier to train the school graduates, the enlargement of opportunities in this field could no longer be ignored by the school system. Yet the wider problem of providing the basic requirements to a majority of schools could not be ignored. The issue was decided by accepting the argument that introduction of modern educational technology on a phased basis, beginning with the largest schools would not necessarily interfere with the wider goal of upgrading the entire school system. Thus all schools which had Advanced Level Science streams were given large colour TV sets - and the larger of them video recorders - in 1982, in anticipation of the initiation of educational TV broadcasting in late 1982. This hastened the decision to introduce microcomputers to schools. With the issue of where to start, if at all, thus decided, microcomputers, which were cheaper than colour TV sets, could be given to the largest of those schools which had already received TV sets. The need for a modest beginning as regards teacher training was also thus met. This decision was made in the last week of 1982 and the school programme began within one year, in 1983.

The school computer programme

Cabinet approval was obtained within one week of the Ministry decision to introduce computer education to schools and the type of machines to be bought for school use and for teacher training were also decided at the same time. The cheapness as well as the availability of the 30-hour Basic BBC television programme of the National Extension College, made the Ministry of Education choose the 8-bit CPU, 16K RAM, Sinclair Spectrum for school use. The language for initial use was also BASIC. For teacher training centres, which were also to be sited in schools, Commodore and VIC systems were decided upon in addition to Sinclair Spectrum's. The suppliers of Commodore and VIC computers also provided the master teacher trainers access to their Wang equipped facilities. Initially 187 Sinclair Spectrum's were bought and 108 schools provided with teaching facilities. These kits also included audio tape recorders and manuals.

Objectives of the programme. In view of its initial phase and in view of the general education focus of the school curriculum the objectives are to:

i) introduce the concept of modern computing to GCE (A level) pupils;
ii) introduce them to a programming language - BASIC;
iii) acquaint them with the use of computers in education, business, science and industry; and
iv) suggest the feasibility of using computers as teaching aids.

It was accepted that with the availability of facilities, pupils will be motivated to go beyond these objectives. Provision has been made to start computer clubs and school newsletters to facilitate such developments.

Teacher training programme. The initial training programme began with the training of the Ministry project personnel and the teachers who were to manage the six training centres. The computer and electronics facilities at the Colombo, Moratuwa and Peradeniya Universities were readily made available to the Ministry. The BBC-equipped Colombo University took a leading part in the training programme. The three universities have taken a major role in teacher training and syllabus preparation with about 200 teachers initially selected for training.

THAILAND

Computer education

Computer education in Thailand started 20 years ago at Chulalongkorn University and the National Statistical Office. The first major computer courses were the introduction to data processing, computer language, programming, numerical analysis and some hardware courses. After that, attempts were made by some universities to offer more advanced courses such as data structure, system programming, and system analysis and design. It is estimated between 2,000 and 3,000 students have taken computer courses. The average number of computer science credits is approximately six and the number of those who have taken more than 9 credits on the subject is believed to be almost 500.

At present, there are about 15 universities in Thailand that provide computer courses. At graduate level, there are three courses with strong emphasis on computer science. These are the M Sc (Computer Science) at Chulalongkorn University, M S (Applied Statistics) with major in computer at the National Institute of Development Administration (NIDA) and M S or M Eng in computer at the Asian Institute of Technology (AIT).

Computer education is not only provided in universities and colleges but is available to other groups of people. Computer vendors have set up private computer schools for promoting their products, coinciding with the widespread availability of microcomputers. For these reasons there is a big boom in computer education at this moment. It is estimated that over 20 private computer business schools in Bangkok are currently in operation. Some are extensions of computer companies, and others are private colleges and commercial schools offering several other programmes. A few private companies have been set up specifically as computer schools. Almost all of them concentrate on programming languages and application packages for microcomputers. The few exceptions offer more general applied courses such as programming in business and systems analysis and design. Over 2,000 people are believed to attend such courses annually. Most of them already have their own jobs, usually with private business firms and want to take these courses to improve their work status.

Some of the computer companies have training divisions, the training courses being almost exclusively for their clients, prospective clients or their own personnel. The vendors offering training courses to the public are primarily new companies selling microcomputers.

Large organizations owning mainframes usually hold in-house training sessions run either by themselves or in co-operation with microcomputer vendors. The National Statistical Office (NSO), a government computer centre, has been holding training courses for government officials for over ten years. In 1984, 15 courses were offered. They attracted over 1,000 applications, of which about 600 were successful. NSO is the only computer centre not directly in the education field which has regularly conducted "open" training courses.

Computer education is now accepted at secondary school. In 1983 some schools acquired microcomputers and started offering short courses as supplements. The trend will probably be continued. Four or five commercial schools are offering some programming courses.

The educational management information system

The educational system in Thailand is divided into three levels: primary, secondary and higher education. The primary, secondary and some of the higher education institutions are under the responsibility of the Ministry of Education, but most higher education institutions come under the Ministry of University Affairs. Moreover the Ministry of Education has to take responsibility for non-formal education, religion, art and culture.

The decision-making of all administrators must be rapid to cope both with current and long-term decision making. Any delays in decision-making by the administrators may cause many problems and have an affect on all projects. So the administrators need urgent and accurate data to support their decisions.

At present educational management information systems have been developed by three organizations namely, the National Education Commission, the Ministry of University Affairs, and the Ministry of Education.

The National Education Commission developed information for educational planning and development covering primary, secondary and higher education. The central function of the information system developed was the creation of a database and the translation of complex data into comprehensible information for policy-making, planning and routine processes of educational administration. Two database subsets were planned. The first subset was the educational database consisting of five files, the second the educational related database of three files.

The Ministry of University Affairs, Chulalongkorn University started a computerized data bank in 1975. At Chulalongkorn University, a concrete programme to implement an information system has been worked out. The University decided to launch a project called

"Management Information System for Chulalongkorn University" or MISCU.

Phase I of this project has been completed. Data have been defined and a database created. A data dictionary has been compiled and Data Point 5500 was installed in 1979, with a terminal connected to the finance office to process university payroll and another terminal is to be installed at the personnel office, with others planned in the near future.

The Ministry of Education has developed the concept of the educational management information system by establishing an educational management information system centre. This centre will collect data and information concerned with students, personnel, finance and equipment. During 1985, the project will extend the computer system to the Regional Education offices so as to enable them to assume responsibility for provincial and regional data processing.

Computer education in school

In 1983 the private and public secondary schools started offering an elective course in microcomputer. The Ministry of Education recognized the importance of computer use for daily living, so the Ministry of Education established their policy on teaching computer in the upper secondary and vocational schools. The main objective of the course is to develop basic understanding of a computer system and the ability to write simple programs.

As a result of the above policy, the Institute for the Promotion of Teaching Science and Technology (IPST) was assigned by the Ministry of Education, to develop the computer curriculum, teaching materials, teacher training, follow-up and evaluation.

The Department of Teacher Education is responsible for training teachers for the Ministry.

Therefore, it has appointed six Teacher Colleges to train teachers for teaching computer. Sixty teachers will be trained by each of the six Teacher Colleges each year. This project started in May 1985. The first group of 360 teachers to teach computer courses in the schools will graduate in 1987.

Teaching computer is not limited only to the Universities and Colleges but has begun to expand to the upper secondary schools. Many secondary schools provide microcomputers in order to offer special short-courses for some groups of students. Most are the large-size schools. These schools are supported by Parent and Teacher Associations (PTA) and Student Alumni Associations and also the computer vendors. Many private schools have received the approval of the Ministry of Education to teach computer courses. The IPST was assigned by the Ministry of Education to set up a computer curriculum in August 1983. The IPST is also responsible for computer teaching at the upper secondary schools level, and the production of teaching materials including textbooks, teacher manuals, and audio-visual aids as such videotape, slides, transparencies and programmed texts. Two trial computer courses for the upper secondary schools and vocational schools began in three pilot schools in 1984. The textbooks for the pilot schools were printed by the IPST. After the teaching materials have been tried by the pilot school the IPST will evaluate the outcome in order to improve them. The objectives of the computer courses are to develop:

a) basic understanding of a computer system;

b) perceptions of appropriate work for computer;

c) the ability to apply problem solving algorithms to the work by computer;

d) the knowledge of programming and the ability to write simple programs;

e) the ability to run a simple computer program; and

f) logical thinking, systematic thinking, carefulness and creativity.

The two computer courses for the upper secondary schools are elective courses. Each course uses three periods per week per semester. The first course which is a prerequisite for the second is mainly a basic introduction to the computer. The second course includes basic computer language programming. For effectiveness of computer teaching in the school, the criteria established by the Ministry of Education was for schools to procure CPUs, Keyboards and Monitors - at least one set per five students - and that there should be no less than ten students enrolled in each computer course. By mid-1985, the Ministry of Education will implement the computer curriculum for the upper secondary school level throughout the country. The schools, ready for computer teaching can request the teaching materials from IPST.

Part Two

PROVIDING COMPUTER SERVICES

Singapore

PROVIDING COMPUTER SERVICES

To maintain its high rate of economic growth, Singapore must move to higher technology-based industries and services. The population must be adequately trained in the use of computers. To this end the Ministerial Committee on National Computerization was appointed by the Government to formulate a strategic plan to establish Singapore as a centre for computer services.

The National Computer Board, established in 1981, implements the plan through the Civil Services; co-ordinates computer education and training; and develops and promotes the computer services industry. A pool of professionals has been built up; three computer training institutions established; and a board-level Computer Education and Standards Committee appointed to advise on the policies and issues pertaining to computer education and standards. The Board sets and maintains professional standards through examinations and national certification.

SINGAPORE

Background on the development of computers in society

Singapore is a small nation, with hardly any natural resources other than its 2.5 million people. To maintain the high rate of economic growth, it must move to higher technology based industries and services. The key to success in the switchover to the new industries lies in preparing the people to acquire the new skills that are required. The most vital new skill is the use of information technology or computers.

In 1980 a Ministerial Committee on National Computerization (CNC) was appointed by the Singapore Government to formulate a strategic plan to establish Singapore as a centre for computer services. In 1981 the National Computer Board (NCB) was established to implement the strategic plan formulated by CNC.

National Computer Board (NCB). NCB has three major statutory functions. They are to:

a) implement the computerization of the Civil Services;

b) co-ordinate computer education and training; and

c) develop and promote the computer services industry.

NCBs first priority was to build up a pool of computer professionals to meet the operational requirements in the implementation of the projects under the Civil Service Computerization Programme.

To address the shortage of computer manpower, three computer training institutions - the Institute of Systems Science (ISS), the Japan-Singapore Institute of Software Technology (JSIST) and the Centre for Computer Studies (CCS) were officially set up in 1981-1982. Together with the Computer Science Department of the National University of Singapore, these institutions will be producing the bulk of the computer manpower requirements for the country. The first batch of students has already graduated. By 1985, the combined annual output of the four institutes will be between 600 to 700 new computer professionals. The task of the NCB is to help these institutions produce the right kind of computer manpower and in the required numbers.

A board-level Computer Education and Standards Committee comprising representatives from the NCB and the training institutions was set up on 1981 to advise on the policies and issues pertaining to computer education and standards. NCB has the statutory responsibility to set and maintain professional standards through examinations and national certification. A Professional Examination Secretariat was set up in 1982 as an executive arm to implement these policies and NCB successfully concluded a joint examination agreement with the British Computer Society for the conduct of the BCS-NCB Examinations in Singapore. The tie-up with the British Computer Society has provided a recognized standard with which to measure the computer professionals. It is the intention of NCB to seek a similar tie-up with other recognized examination bodies in Japan and the United States of America.

NCBs first priority was to build up a pool of computer professionals to meet the operational requirements in the implementation of the projects under the Civil Service Computerization Programme. Steady progress was made over the past two years.

A Software Engineering Department was also set up in 1981 to provide support to the Civil Service computerization effort through the evaluation of hardware and software, and to undertake research activities like office automation, networking and workstations in readiness to introduce these technologies into the Civil Service environment.

In the area of developing and promoting the computer services industry, an Industry Development Department was established in 1982 to develop and promote the computer services industry.

The priority tasks have been to collect information about the state of the industry locally and in the region, selectively promote overseas computer companies that can bring in expertise to effect technology transfer and assist the local computer industry with its more pressing problems.

Trends and issues in different domains of education

NCB has a board-level committee that looks into computer education and training matters. This committee comprises Board members and representatives from professional bodies, a number of government-sponsored computer education institutes, the National University of Singapore and the Ministry of Education as well as representation from the Board's own Professional Examination Secretariat. The committee advises on manpower planning, education programmes, the establishment and maintenance of professional standards.

NCB conducted a survey in 1982 to estimate the demand for computer professionals. The survey shows the tremendous growth of the computer services industry in that the demand for computer professionals during the period 1982 to 1985 is an additional 3,900.

(Table 1). This demand represents a 34 per cent average annual increase in the existing pool of computer manpower. This increase can be attributed to the response of all economic sectors to the national policy of promoting computerization.

Various programmes have been initiated in order to increase the supply of trained computer professionals. The programmes include:

a) increasing the intake of Computer Science students at the National University of Singapore by over 50 per cent since 1981;

b) establishing the Institute of Systems Science to train graduates to be systems analysts;

c) setting up the Japan-Singapore Institute of Software Technology; and

d) setting up the Centre for Computer Studies in the Ngee Ann Polytechnic.

Various programmes have also been set up in schools and the community centres to expose as many people as possible to computers.

Current activities of the institutions

Computer Science Department, National University of Singapore. Since 1981, the Computer Science Department has increased its intake of students with the aim of producing some 200 graduates per year from 1985 onwards. This is approximately 30 per cent of the 600 to 700 new computer professionals that the NCB hopes to produce every year in order to meet the projected computer manpower requirements.

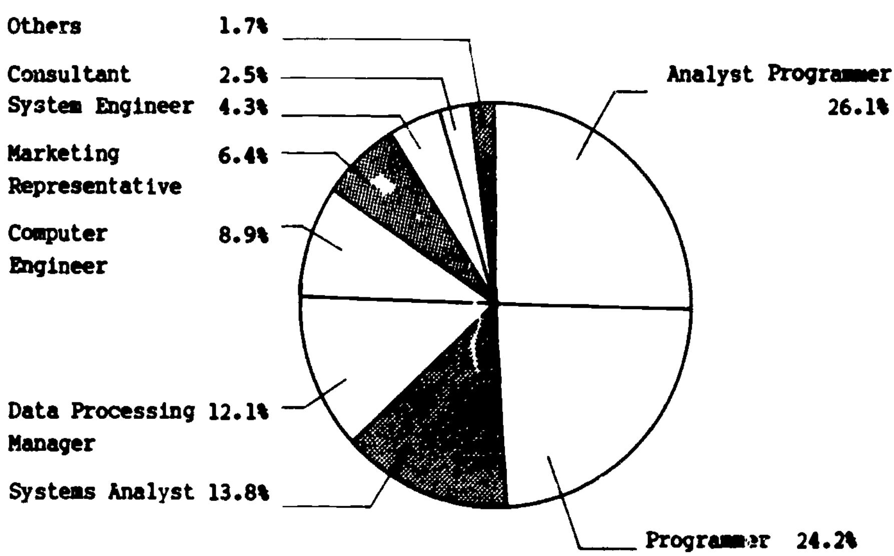
In line with the rapidly changing demands of computer technology, the syllabus for the Computer Science course is constantly reviewed and changed to meet the needs of the computer industry.

Institute of Systems Science. The Institute of Systems Science provides training for public and

Table 1. Computer professionals

	Number of personnel as at 1982	Additional computer professionals required 1982 to 1985
Programmer	692	1,023
Analyst Programmer	747	850
Systems Analyst	395	608
Data Processing Manager	346	251
Computer Engineer	253	365
System Engineer	124	250
Marketing Representative	182	305
Consultant	72	138
Others	46	143
Total	2,857	3,933

Computer professionals as at 1982



private sector computerization through innovative programmes in Quality Management Education, Advanced Technical Training, Consulting Service and Applied Research in information systems.

Established in 1981 at the National University of Singapore, the Institute is a key resource in the computerization efforts of the public and private sectors in the region, the development of Singapore as a centre for computer services, and in the provision of expertise at the upper end of computer technology. Each year, some 100 new systems analysts will be trained. Applicants for admission to the institute must have a basic degree.

Japan-Singapore Institute of Software Technology. The JSIST was established under a technical agreement signed in 1980 between the Government of Singapore and Japan. The JSIST was set up under the Economic Development Board to facilitate the transfer of Japanese information technology to Singapore. Under the agreement, the Japanese Government provides technical assistance to Singapore for the planning, establishment and operation of the Institute via a resident team of Japanese software experts for a period of five years.

Opened in 1982, the JSIST accepts students with at least "A" level qualifications for their two-year full-time training courses in programming and systems analysis. The first batch of 50 students was admitted to the JSIST in 1982. They graduated in early 1984.

Centre for Computer Studies. The third computer institute, the Centre for Computer Studies (CCS), was set up as a joint project between the Ngee Ann Polytechnic and International Computers Limited of the United Kingdom. It was opened in 1982.

The CCS offers computer courses for both "O" and "A" level school leavers. "O" level students will undergo a three-year diploma course while the "A" level students undergo a two-year course. The CCS will produce some 240 computer professionals every year.

Computer education in schools. The Ministry of Education started implementing a Computer Education programme in Junior Colleges and secondary schools in 1980.

At Junior College Level, Computer Science is offered as one of the Advanced Level examination subjects of the "A" level Cambridge GCE Examinations. There are 11 Junior Colleges and about 1,000 students are offering the subject each year. Most of the Junior Colleges are equipped with multi-access minicomputer systems. Teachers have been trained to teach the subject by the National University of Singapore.

Computer Education is introduced to secondary school students through extra curricular activities. One hundred and thirty-four secondary schools have set up Computer Appreciation Clubs; each with three microcomputer systems. About 700 teachers have been trained to supervise the Clubs' activities. At present, about 13,000 students, which is 8 per cent of the total population of secondary school students, have been enrolled as members of the clubs.

There are plans to increase the membership of Computer Appreciation Clubs to 20 per cent of the student population and to introduce computer awareness courses to all secondary students.

In implementing the Computer Appreciation Course, enough teachers must be trained to take charge of Computer Appreciation Clubs. Since 1980, the Curriculum Development Institute of Singapore under the Ministry of Education has been conducting part-time in-service computer appreciation courses for teachers. A microcomputer laboratory with 20 microcomputers was set up in CDIS to conduct such in-service courses. The course lasts for 100 hours and is practice-oriented. It covers a fundamental knowledge of computer and its applications, BASIC programming, computer graphics and file processing.

Computer education for the general public. For the man-in-the-street, microcomputer appreciation classes have been organized by the People's Association, the National Trades Union Congress and the Singapore Armed Force Reservist Association. These classes promote computer awareness throughout all levels of society.

Between the three organizations, over 30,000 people have undergone various microcomputer courses ranging from the basic microcomputer appreciation courses to courses that teach participants programming languages.

Part Three

IMPACT OF MICROCOMPUTERS ON LESS-DEVELOPED COUNTRIES

IMPACT OF MICROCOMPUTERS ON LESS-DEVELOPED COUNTRIES

H.N. Mahabala*

Whereas microcomputers have entered the market in developed countries as personal computers, they have been viewed as low-cost replacement for mainframe computers for business in less-developed countries (LDCs). As such, the expectations are quite different. Wide variations in business practices prevents the large-scale use of packages. Finding programming manpower for these microcomputer- based centres has also been a problem. Professional computer societies have to play a key role in meeting the expectations of those who have acquired these microcomputers.

There is an urgency to introduce distributed computing based on Local Area Networks to utilize small systems effectively. What is interesting is that the expertise of senior computer professionals, based on their experience with large systems, is somewhat out of place in the case of microcomputers. This paper discusses suggestions based on the Indian experience for professional reorientation towards small systems.

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Introduction

Advances in microcomputers have come about faster than the rate of absorption of that technology into the developing countries. Considering that even IBM did not anticipate its impact in the early days, the chasm between availability and effective use of microcomputers in developing countries is understandable. An important factor which contributes to this gap is the inability on the part of yesterday's top-notch computer professional to re-evaluate his hard earned wisdom in the light of new developments. For example, one used to swear by the centralized approach whereas the best way to benefit from microcomputers is through decentralization; one used to believe in the development of customized applications whereas employing packages is the way to use small systems. Microcomputers have so destabilized the position of yesterday's computer expert that some cynics may be tempted to say that senior professionals are the biggest impediment in the way of effectively using microcomputers! It is very difficult to make statements which apply to all developing countries or to every aspect of any one developing country. This article attempts to discuss the microcomputer scene in developing countries (or LDCs -- less developed countries as some would prefer to refer to them) with the Indian scene as a backup.

Indian microcomputer scene

Computer manufacturing in India in the last three years has been essentially microcomputer-based, with one or two exceptions. There are about 40 vendors and the emphasis on 8-bit based systems is gradually shifting towards 16-bit based systems. However, the 8-bit based personal computer market is also growing. As is true elsewhere the number of micro-based systems installed in 1983-1984 is more than the total number of systems installed in the previous 20 years. Herein lies the temporary (it is hoped) inability of the established computer community to adjust to the shift in emphasis from the mainframe to the micro.

Professionals obsessed till recently with issues connected with medium and large systems cannot appreciate the totally different approach necessary in the case of micros.

Whereas microcomputers entered the market in developed countries as personal computers because of their affordable price, they have entered the Indian market as affordable small business systems. Because of various factors the price of a small system (identical to a personal computer in the developed market) is not within the reach of an individual. Whereas a PC (not necessarily IBM) in the West costs less than the annual savings of a salaried person, its price in the Indian market is more than the annual gross earning of even well-paid professionals. One cannot anticipate too much change in this situation in the next few years and as such, micro-based systems will be enterprise-oriented systems rather than being individual-oriented. Thus they will be called upon to fill the role of the main computer systems of yesterday -- therein lies the problem and the challenge.

Even in developing countries printers and auxiliary storage devices are expensive compared to the processor; the problem becomes more acute in the Indian situation where the system has to serve organizations which have to necessarily print large amounts of output and store large amounts of data. The enthusiasm generated by the low-priced processor is dampened by the high cost of peripherals. Luckily, the availability of low-cost semiconductor memory has removed the inconvenience of having to work with low-level languages or poor software tools.

Strangely enough, in a country where over-population is an issue, the problem of computer manpower is as acute as elsewhere. Programmes are being initiated to generate manpower at various levels. However, it is disconcerting to note that the trained people are not attracted to work for the small companies which have acquired microcomputers. They do not see opportunities for professional growth in such computer centres. If it is a problem even to get a programmer, how much more difficult will it be to get a mature systems analyst who alone can really design appropriate systems to use the microcomputer effectively? Thus, one sees many microcomputer-based centres starved of the necessary manpower, resulting in disillusionment among the managers in the company regarding microcomputers.

It is now well accepted in developed countries that one cannot afford the luxury of programming a microcomputer to develop applications along the lines one used to do in the case of mainframes. This approach unfortunately cannot be followed in India. First, business practices between companies are so varied that a package is rarely usable. Secondly the package becomes a cheap solution only if its price, as determined by the number of places using it, is low. With the difficulty of providing protection to the package vendor from unauthorized use (and copying) many enthusiastic entrepreneurs have withdrawn from the package development activity. In the opinion of the author, reluctance on the part of business to adjust its practices to the software available will reduce in the course of time, but making it worthwhile for package developers to produce low-cost packages will not be as easy to solve.

Many entrepreneurs have entered the field to provide data processing services based on microcomputers. But their experience is not all that encouraging. One needs expensive peripherals in service bureau operations as compared to in-house use. The proliferation of service bureaux has increased competition to a point that revenues are not realistic. Many are forced to keep busy just to reduce losses let alone to make a modest profit. One can only hope that the user becomes pragmatic enough to want to pay 'what it costs' and thereby get 'what is promised'. The growth of informed users of services or equipment is a necessary prerequisite for the establishment of a viable computer industry.

Microcomputers are more or less used as low-cost substitutes for the main computers of yesterday. One even hears of salesmen talking of the number of terminals one can connect to systems just because the hardware provides for it. Business has yet to realize the enormous benefits of distributed processing which the microcomputer is ideally suited to. There is very little use of point-of-sales terminals or direct data entry. Orientation to batch processing, and the consequent dependence on documents, prevails. There are however a few exceptions.

With the increasing trend towards single world sources for computer subsystems, such as chips, printers, disk drives etc., even in developed countries, one can understand the fact that the Indian computer industry is essentially configuration-oriented. However, one sees the menace of what some call 'screwdriver technology'. New vendors spring up overnight selling a new system shown in the latest computer exposition in a developed country. Perhaps the new system has advantages compared to earlier systems, but it is being introduced by a party who has very little to do with its development and consequently has very little basis for providing user support. Of course, the buyer is not sophisticated enough to see the problems and is moved by the reviews of the new system in the foreign journals. There is very little incentive either to develop a new product ab-initio or to modify existing systems in the light of new developments in the field. In the opinion of the author, this factor of 'screwdriver technology' could slow down the effective utilization of microcomputers. One cannot forever chase the latest expo. There is a silver lining in the sense that users are becoming aware of the problems in buying from a vendor who is more or less a selling agent, with no facilities to make available to the user and who does not have the support of the original developer of the product.

Recently, the Government of India initiated a 'Computer Literacy Programme' on an experimental basis in 250 secondary schools. The programme will use a micro-based system with colour graphics. Emphasis in the programme is on making all students (both science and non-science) aware of the potential of computers through the use of good software packages rather than through the conventional programming approach. The programme is ambitious and is intended to be extended to cover 55,000 secondary schools in the first phase and 700,000 primary schools in the second phase. One wants to prepare children for the high-tech world of tomorrow through hands-on experience on microcomputers. Apart from the highly desirable objective of removing the fear of high-tech in general, and of computers in particular, from the citizen of tomorrow, such a programme is also good in providing an impetus to the growth of an indigenous computer industry by generating significant volumes of various subsystems. An 8-bit microprocessor and associated chips which can be used in such a system will be manufactured in India. Undoubtedly, for every school computer many more would be absorbed in business and industry and thus the industry (hardware and software) is expected to get a big boost.

There is a mushroom-like growth of teaching shops providing computer training. Fortunately, with the availability of low-cost microcomputers one does not hear complaints any more about theoretical training without adequate hands-on experience. However, computer professionals are still worried about the graduates of such programmes. They seem to know very little besides the syntax of programming languages. Since these shops will have to provide the manpower for microcomputer-based centres there is an urgent need to establish standards for such training and some means to enforce them.

Lest this review of the Indian scene be interpreted as somewhat negative, one must recognize the growing computer awareness among users. Word processing has taken a strong hold. Research and development has been initiated to provide word processing in various Indian languages. There is a healthy growth of computer-based magazines which are keeping the user informed of both the good and the bad. Undoubtedly, it is the magazines that will protect the user from the industry and consequently help in the growth of a healthy industry. Even leading newspapers have started publishing computer-oriented articles in all aspects from technology to computer-based business practices.

Suggestions for a plan for action

This author feels that the scene in other LDCs is not very much different. Technological advances promise a computer on every table but the matching manpower, or information orientation, in an enterprise is very hard to mobilize. Following are a set of suggestions worthy of serious consideration by professional societies in LDCs.

i) Computer professionals and their societies are obsessed with mainframes. Not enough is being done to help the users of microcomputers. Their activities must become small computer oriented, and forums must be created to discuss all aspects of a microcomputer installation including the installation itself, the manpower and the selection of packages.

ii) One can certainly try to monitor the standards of teaching shops. After all, they are only helping (or, as some say, taking advantage of) those who want a computer-oriented career. Assessing objectively the aptitude of a candidate is as important as the subsequent training. Professional societies should provide opportunities for graduates of these programmes to learn about those aspects which they feel are lacking in their training. The emphasis should not be on complete training by the society but on 'make-up' training. One can provide lectures on real-life applications and discussions on meaningful case studies (however micro-oriented).

iii) Professional societies must recognize the importance of small computers and bring them into the fold through appropriate measures, such as having separate divisions for small computers. It is needless to mention that if it is not done soon, the societies may alienate themselves from the majority of computer users.

iv) Small computers are best used in a distributed way. As such one must emphasize the parallel growth in computer communications. Vendors must be encouraged to introduce products oriented to Local Area Networks. It is possible to provide logical networks using floppy diskettes for the exchange of data. Experiments show that a distributed approach based on floppies can be quite effective.

v) Graphics have not been emphasized sufficiently in data processing circles. With school computers going for colour graphics how can professional applications still be text oriented?

vi) Whereas it is not necessary to have local language based programming languages, one must emphasize the need for data processing using strings in local script, e.g. to print bills. This is one way the computer can be brought closer to the common man in an LDC.

vii) The future belongs to programmer-less, single-application oriented. dedicated systems. Obviously, the design of software for such systems which are to be used by lay users needs special attention. Computer education institutions must orient their curricula to train software engineers to develop packages.

viii) Professional societies must develop extension programmes to advise lay users in the selection of hardware and packages. They should also operate better business bureaux to monitor activities of 'fly-by-night' vendors.

ix) Countries must view microcomputers as 'mother technology' and take policy decisions to provide hardware at international prices (i.e. the lowest possible) and enforce laws in order to make the development of packages worthwhile for the vendor.

x) One can expect in the near future, greater impact of microcomputers in the 'information industry' rather than in data processing. One should think in terms of 'electronic publishing', based on diskettes to provide information support to development. A centralized data base can be used to produce information tailored to the local context, say of a rural community which is distributed through floppies to be used at local information dissemination centres. At a later date one can replace the transportation of floppies by data communications. Undoubtedly, one cannot reap the full benefits of microcomputers without matching data communication facilities. However, one can do a lot with transportable media.

xi) Rapid advances in Hardware technology have made standardization difficult. One thought that the 8-inch floppy was going to be the standard only for it to be replaced by 5-inch and now 3-inch diskettes. An imaginative approach is needed to provide a measure of protection to the microcomputer user. Professional societies in LDCs must help in arriving at a plan of action.

xii) As has been demonstrated in the United Kingdom, radio and television media can be used to distribute software and data bases in LDCs along the lines of CEEFAX.

xiii) The computer profession was obsessed in developed countries up to a few years ago, with the 100 per cent utilization of the processor. One still sees such an approach in LDCs. One must reorient the profession to a user-oriented approach which places only appropriate importance on hardware utilization. Also one cannot directly adapt applications on large systems to small systems. A new approach to system design is needed. The chances are that micro-based networks will provide better decision support to an organization than centralized systems.

xiv) Because of the economics, microcomputers in LDCs cannot take the place of personal computers in developed countries. Therefore one has to develop strategies for using them as small business computers. One will not find relevant experience in developed countries in such usage which is directly transferable to LDCs.

In summary, the expectations of a microcomputer in a LDC are different from those in a developed country. They have to serve as workhorses for small businesses. Computer professionals in LDCs have to orient themselves to this challenge, since almost every wisdom about a large system is not applicable in the case of a small system.

The Asia and Pacific Programme of Educational Innovation for Development (APEID) has as its primary goal to contribute to the building of national capabilities for undertaking educational innovations linked to the problems of national development, thereby improving the quality of life of the people in the Member States.

All projects and activities within the framework of APEID are designed, developed and implemented co-operatively by the participating Member States through over one hundred national centres which they have associated for this purpose with APEID.

The 25 Member States participating in APEID are Afghanistan, Australia, Bangladesh, China, Fiji, India, Indonesia, Iran, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Samoa, Singapore, Socialist Republic of Viet Nam, Sri Lanka, Thailand, Tonga and Turkey.

Each country has set up a National Development Group (NDG) to identify and support educational innovations for development within the country and facilitate exchange between countries.

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The programme areas under which the APEID activities are organized during the third cycle (1982 - 1986) are:

1. Universalization of education: access to education at first level by both formal and non-formal means;
2. Education for promotion of scientific and technological; competence and creativity;
3. Education and work;
4. Education and rural development;
5. Educational technology with stress on mass media and low-cost instructional materials;
6. Professional support services and training of educational personnel;
7. Co-operative studies and innivative projects of research and research-based experimentation related to educational development.