CLASS

COMPUTER LITERACY
AND
STUDIES IN SCHOOLS

CLASS

Computer Literacy and Studies in Schools

REPORT OF THE NATIONAL WORKSHOP ON COMPUTER LITERACY CURRICULUM HELD AT NCERT ON 26-27 MARCH 1984

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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FOREWORD

In recognition of the role that the computer has come to play in different fields of human activity, and in keeping with its policy of developing education so that it equips the student to occupy his rightful place in a technologically advancing society, the Government of India has decided to initiate a computer literacy project for our schools this year.

As a first step in this direction a National Workshop, the first of its kind in India, was organised during 26-27 March 1984 by the National Council of Educational Research and Training (NCERT) in collaboration with the Department of Electronics, the Ministry of Education and Culture and the Indian Institute of Technology, Delhi, to examine the implementation of this new project. This report records the deliberations and gives the major recommendations of the Workshop in which more than 40 institutions and agencies were represented by nearly 100 participants.

I believe that the various conclusions drawn during the Workshop, and its recommendations, would be useful to all those who have taken upon themselves the challenging task of introducing computers into our school classrooms. On behalf of the NCERT, and personally too, I would like to express our sincerest thanks to all who made the National Workshop on Computer Literacy Curriculum a success.

P.L. MALHOTRA
Director
National Council of Educational Research and Training

New Delhi
14 May 1984

PREFACE

The use of computers is expanding so rapidly that their presence can no longer be denied or ignored. The information technology revolution is quickly sweeping the world and it is estimated that the world market in information technologies in the year 1990 would be around Rs. 6,000 million a day (Rs. 2,200,000 million per annum). The revolution will change the market-place, both in terms of products and the mode of utilisation of these products. It will change the way the people interact with each other, change the quality of decision making, based as it would be on immediately interrogatable, comprehensive information bases. Also, the nature of an individual's role in this process would change most dramatically. Markets for traditional products will gradually give way to information technology products. Industries which do not incorporate the new technology into their products will soon become uncompetitive and non-viable. The ability to carve out a share of this market will depend critically on the availability of people trained in the necessary skills pertaining to computer operation.

The education we are imparting today to our children would reflect on the potentialities of tomorrow's work force. There is, therefore, a great need to expose today's children, who are in primary and secondary schools, to the nature and uses of computers in order to make them capable of coping with the present and the future technological society. Anybody who grows up in the world of tomorrow, not knowing computers, not understanding computers, not being able to use them, will be lost, and that country which does not prepare its citizens to be fully familiar and conversant with computers, their technologies and their applications would not be able to keep its place in the industrial heirarchy in the community of nations.

Realising this, the Department of Electronics, with close cooperation of the Ministry of Education, is launching a programme for Computer Literacy and Studies in Schools (CLASS) on a national scale. A pilot project has been formulated to introduce computers into 250 schools during the financial year 1984-85. The programme is expected to be extended to other schools after the completion of the pilot project. The extension of the coverage in the Seventh Plan would be decided after assessing the lessons of the pilot project and taking other relevant aspects into account.

In order to prepare teachers' and students' curricula for the pilot project, a Workshop was organised at NCERT, New Delhi, on 26 and 27 March 1984, in which representatives from various resource centres, IITs, engineering institutions, TIFR, Central Board of Secondary Education, Kendriya Vidyalaya Sangathan and some schools participated. The response of the participants was very encouraging despite the very short notice given to them for attending the Workshop. Discussions on curricula, evaluation and monitoring and management of the pilot project were held at great length. As a computer education programme with similar objectives has been recently implemented successfully in the United Kingdom, a brief presentation regarding their experience was also arranged during the Workshop. The report of the Workshop has been prepared by NCERT. Section I of the report describes the various conclusions and recommendations of the Workshop while the proceedings of the various sessions have been given in Section II. Working papers have also been included in the report along with addresses.

I hope this report will help in providing suitable guidelines on issues related to the implementation of the CLASS Project.

ASHOKA CHANDRA
Director (Manpower)
Department of Electronics
Government of India

New Delhi
19 May 1984

INTRODUCTION

In the final year of the Sixth Plan, i.e., 1984-85, a pilot project—Computer Literacy and Studies in Schools (CLASS)—has been proposed to be launched by the Government of India. The Department of Electronics, in collaboration with the Ministry of Education, had constituted a Committee consisting of members drawn from the Department of Electronics, Indian Institute of Technology, National Council of Educational Research and Training (NCERT), Central Board of Secondary Education and the Kendriya Vidyalaya Sangathan to work out details of the teacher training programme, curriculum for students and other academic activities under the programme. The Committee held its first meeting on 20 February 1984 and decided to organise a National Workshop for considering the outline of the programme The National Council of Educational Research and Training decided to organise the National Workshop in collaboration with the Department of Electronics, the Ministry of Education and Culture and the Indian Institute of Technology, Delhi.

In its first meeting held on 23 February 1984, the Planning Group constituted for the purpose decided to hold the Workshop on 26 and 27 March and to invite participants from resource centres identified under the project, including the IITs, Regional Engineering Colleges, Tata Institute of Fundamental Research and Central Board of Secondary Education.

Nearly 100 representatives from more than 40 institutions and agencies participated in the Workshop. Professor P.L. Malhotra, Director, NCERT, acquainted the participants with the Workshop's objectives in his welcome address and Professor S. Sampath, Director, IIT, Kanpur delivered the inaugural address. Professor C.S. Jha, Educational Adviser (Technical), Shri Y.N. Chaturvedi, Joint Secretary, Ministry of Education and Culture and Professor Ashoka Chandra, Director (Manpower), Department of Electronics, moderated the discussions in the different sessions of the Workshop. Professor T.N. Dhar, Joint Director, NCERT, acted as the Chief Rapporteur of the Workshop.

The major technical aspects of the Pilot Project were introduced by Professor Ashoka Chandra, Professor S.N. Maheshwari, IIT, Delhi, Professor A.N. Maheshwari, Regional College of Education, Mysore, and Professor A.K. Jalaluddin, NCERT.

A team of British experts, consisting of Mr. G.J. Mungeam, Dr E.B. Bates, Mr P. Lewis, Mr. John Radcliffe and Mr. Bob Coates, shared their experience of implementation of the Computer Literacy Programme in the U.K.

Mrs. Serla Grewal, Secretary, Ministry of Education and Culture and Dr. P.P. Gupta, Secretary, Department of Electronics, addressed the participants in the concluding session of the Workshop.

Technical assistance to the National Workshop was provided by :

Ministry of Education and Culture

Prof. C.S. Jha
Shri Y.N. Chaturvedi
Shri R.C. Sirohi
Smt. Renuka Mehra

Department of Electronics

Prof. Ashoka Chandra
Shri S.N. Zindal
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NCERT

Prof. A.K. Jalaluddin
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REPORT

MAIN RECOMMENDATIONS

Framework

The basic framework of the project, drawn up by the Department of Electronics and elaborated through discussions between the Ministry of Education and NCERT, for providing computer literacy to students enrolled in Secondary/Higher Secondary schools, was generally agreed upon. The main objectives of providing computer literacy to students were accepted. It was felt that the programme should, in the first phase, fulfil the following objectives :

—provide students with a broad understanding of computers and their use ;
—familiarise students with the range of computer applications in all walks of human activity and the potentiality of the computer as an information processing tool;
—de-mystify 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 the immediate environment of the child.

2. However, the computer literacy programme which was drawn up could be regarded only as the first step in promoting the use of computers in a variety of situations. While selected schools would, in the first phase, be concerned with the computer literacy programme, simultaneous efforts would have to be made in some select institutions to experiment with computer assisted instruction/learning and for introducing computer related courses at the plus two stage.

3. It was felt that introduction of computer literacy would have a liberalising influence in schools, by making teachers sensitive to and ultimately capable of utilising the computer for improving the effectiveness of instruction.

4. Although the number of schools (250) included in the first phase was felt to be rather small considering the large number of secondary schools in this country, it was agreed that at the initial stage it would be

desirable to make a modest beginning. From that point of view, 250 schools could be regarded as a reasonable number where the experimental phase of the programme could be introduced in a variety of educational situations.

5. Implementation of the experimental programme, which was to commence in the last year of the Sixth Five-Year Plan, should help in :

(a) determining the feasibility of expanding the coverage of the programme in the Seventh and subsequent Five-Year Plans;
(b) identifying problems which will require to be attended to, particularly when the coverage of the programme would be expanded;
(c) identifying the changes that would be required in educational management structures with a view to incorporating the computer as an essential tool for education; and
(d) identifying the modifications that would require to be made in the implementation strategy.

Software Development

6. In the absence of suitable software in large quantities, it would be necessary in the initial stage of the experimental programme to acquire software from non-indigenous sources. In doing so, it would be necessary to identify different sources from which suitable and appropriate software can be obtained, keeping in view the actual teaching-learning conditions in Indian schools. One of the important conditions that the software would have to satisfy would be that it should be culture-free.

7. The effort to develop software indigenously would have to be simultaneously taken up. A suitable strategy would have to be thought of and implemented with a view to ensuring indigenous development of software materials for use in educational institutions. The involvement of teachers in preparation of materials would be essential so as to de-mystify computers, which is one of the objectives of the programme. Ultimately, students would also have to be familiar with the techniques of preparing specific programmes. In case of the brighter and more motivated students, this process could begin in the pilot phase of the programme.

8. In view of the fact that the media of instruction at the school stage are the regional languages, it would be necessary to think of developing software in various Indian languages. For this purpose, necessary steps should be initiated as early as possible.

Role of Resource Centres

9. The framework suggested that schools under the pilot phase

should be linked with the resource centres. Some of the important functions identified for these centres are :

—support/consultancy assistance to teachers of selected schools;
—monitoring the implementation of the programme with a view to particularly identifying problems and their solutions;
—training of teachers of schools covered both in the experimental phase and the wider expansion phase;
—maintenance of computers and attending to some urgent replacement of parts for which purpose the resource centres would have to maintain spares;
—interaction among themselves and also with other educational training institutions;
—development of curriculum and teaching strategies;
—software development, both for computer literacy as well as computer assisted instruction/learning;
—promotional activity with a view to popularising the programme.

Curriculum

10. The curriculum development exercises which had been undertaken earlier were discussed and the outcome presented in the workshop. The curriculum framework proposed for students and for the training of teachers was thoroughly examined. The framework was generally accepted as the basis for further work.

11. It was agreed that although schools should have some flexibility, it would be desirable to have a common and structured format as this would facilitate monitoring and evaluation of the programme. The need for ensuring that the two frameworks did not contradict each other but had an integrated linkage between them was stressed. It was agreed that a small group of experts would be constituted to undertake an in-depth examination of the curricula that were presented in the workshop.

Training

12. Two categories of personnel would be directly involved in the implementation of the programme, viz., first, faculty of the resource centres who would be identified for providing assistance to schools, undertaking training of school teachers and providing back-up facilities and, second, selected teachers from secondary schools. It was agreed that a week's training would be needed for faculty of the resource centres with a view to acquainting them with major objectives and modalities of the pro-

gramme and assisting them in developing a suitable training programme for teachers also.

13. The seminar felt that the minimum duration for training school teachers should be four weeks. It was suggested that this training programme need not be taken up at one go but could consist of an initial exposure followed by intensive training after some lapse of time. It was also stressed that there should be follow-up training, at regular intervals, of teachers who have already been trained under the programme.

14. Although some tentative ideas about the utilisation of school time for computer literacy were discussed, it was realised that the problem of time-tabling would require more serious consideration. While part of the instruction could be given during school hours, some of it would need to be provided after school hours, and on weekends and other holidays. It was agreed that a small group would be set up which would consider various aspects in this regard.

15. It was agreed that the implementation of the programme should commence from July 1984. Although in view of some operational details yet to be worked out, the time available was rather short, the time schedule should be adhered to, to avoid any slackening of efforts.

16. The period available between the workshop and the introduction of the programme would have to be carefully planned for completing some of the essential tasks which would include :

—finalisation of the list of resource centres;
—identification of schools and teachers;
—training of faculty of resource centres;
—details of training of school teachers;
—selection of software;
—printing of informational, instructional and training materials;
—provision of requisite facilities in schools.

17. A variety of materials, print and non-print, would have to be developed and made available to various agencies well ahead of the commencement of the programme in schools. These materials may include :

—detailed write-up about the functions and responsibilities of the resource centres;
—syllabi to be followed for the training of resource persons, school teachers and students;
—instructional materials for use by faculty of resource centres, teachers and students;
—wherever possible, video-tapes which could be used both for training of teachers and students.

18. It would be necessary to provide media support to the programme. Apart from informing the general public about what computers are all about, what they can do and how they function, etc., it would be essential to prepare audio-visual materials in support of the computer literacy programme, computer assisted instruction/learning, etc.

Monitoring and Evaluation

19. Monitoring and evaluation would have to be an essential part of the computer literacy programme as the data that would become available would facilitate expanding its coverage. While monitoring would help in determining the efficiency with which various components of the programme were being implemented at different levels, evaluation would indicate its achievements.

20. All the agencies responsible for the implementation of the programme—schools, resource centres and national level organisations—would have to be involved in monitoring the programme. All the aspects—expenditure, capital investment, appointment of personnel, software development, etc.—would require to be monitored. It would be desirable from this point of view to develop a suitable format on the basis of which information would be collected.

21. Evaluation of the programme in terms of achievement of physical targets, students' attainments, teachers' competencies, experiences for expanding coverage and the extent of the use of computers in the education process, etc., would need to be undertaken by agencies implementing the programme and also in collaboration with some institutions which have sufficient research and academic capability.

22. It was felt that the total scheme of monitoring and evaluation should be worked out by an expert group. Implementing agencies should be informed about the various modalities of monitoring evaluation that would have to be adopted.

PROCEEDINGS

26 March 1984

Morning Session

CHAIRMAN : PROF. C.S. JHA

Inaugural Session

The workshop was inaugurated by Professor S. Sampath, Director, Indian Institute of Techology, Kanpur. In his inaugural address, Professor Sampath presented briefly the background of the growth of the computer and its impact on industrial and technological development. He mentioned the striking advancements taking place over the whole gamut of computer technology and illustrated various capabilities of the computer as a memory system—a machine which staggers the imagination and is capable of performing computational processes. The computer had come in a major way to the help of all professionals. The growth of mini-computers in the early 60's brought the computer nearer to the individual. The mini-computers put the person with the problem in direct contact with the machine and helped in stimulating new concepts in design, manufacture and marketing. Further, these were extensively used for scientific research, industry, business and in chemical laboratories, hospitals, communication, technology, etc. Recently computers have come into use in education. Microcomputers have provided scope for developing analytical skills and contributed significantly to develop excellence in ideas. Computers enabled pupils to participate more actively in the educational processes and developed the ability to initiate action on their own. Computers would become a part of the future culture as well as a powerful storehouse of information. Professor Sampath belied the fear of loosing values if computer-based skills and techniques were introduced in the school system.

He welcomed the decision of the Government of India to embark upon a pilot project on the use of computers in schools. He pointed out that the emphasis in this programme should be both on problems of classroom instruction and supporting laboratory experience. He emphasised the need for identifying motivated teachers and the quality of their training. The effort required a large number of teachers to develop programmes appropriate to our environment. It was, therefore, necessary for computer professionals and teachers in the country to work together and generate computer literacy. He welcomed the collaboration of the British experts who had rich experience in this area for the past many years and had demonstrated successfully the validity and efficiency of computer in their own environment. He suggested that the experience gained in the U.K could be suitably adapted to the environment and culture in our country. To this extent, he expected, that we shall be able to present a coherent approach exercising control to achieve maximum utilisation of resources that are locally available.

Professor Sampath expressed the hope that the workshop would be able to come out with an acceptable document with regard to curriculum for students and for teacher training. It would also result in specifying broad policy decisions and approaches necessary for an effective implementation of the programme.

Director's Address

Welcoming the distinguished participants and guests, Dr. P.L Malhotra, Director, NCERT referred to the introduction of the new 10+2. pattern of school education in the country during the past one decade. He pointed out that paucity of resources--both human and physical—have resulted in limiting efforts to improve the quality of school education and its quantitative expansion. He specifically expressed his concern that equality of opportunity to children of diverse socio-economic backgrounds while promoting innovative curricular practices should be ensured.

He expressed his happiness that the Government of India had decided to introduce the pilot project in about 250 schools for providing computer literacy to students. He supported the role of microcomputers in enhancing the intelligence of young learners and in making knowledge more operative and dynamic. The role of microcomputers in schools and in teacher training had an important affective role in favour of liberalising the process of education and accelerating skill development. He also pointed out the limitations likely to be faced in integrating computer literacy as a new innovative area into the existing curriculum. He suggested a cautious and pragmatic approach to the introduction of computers. Computer literacy should either enable pupils to learn regular subjects better, or help him to acquire some additional important skills having greater employment potential. In this connection, he referred to the availability of software facilities and the need for developing local, culture-based software. Dr. Malhotra welcomed the collaboration of British experts who had rich experience in the field of computer education, and had agreed to demonstrate computer hardware and software used by them in the U.K. and to share their experience with us. He extended his sincere welcome to Professor Sampath, Professor Jha, Professor Ashoka Chandra and all other distinguished participants and guests who were attending the National Workshop.

Introducing the Project

Professor Ashoka Chandra, Director (Manpower), Department of Electronics presented the background paper explaining the plans to introduce computer education in schools and colleges in a phased manner. He spelt out the broad objective and made it clear that the emphasis in this programme would be on manipulative skills rather than on teaching principles of computer science. The basic elements of the scheme, pointed out by him, were as follows :

1. Computer education should be introduced at senior secondary level and may gradually be introduced at middle and primary levels.
2. Computer education would be a part of the curriculum for every student irrespective of the area he selects for specialisation.
3. Computer literacy programme would familiarise students with the computer as a versatile tool with immense application potential in all aspects of human development.

Professor Chandra spelt out the major components of the pilot project. The programme was scheduled to commence from July 1984 in 250 schools throughout the country. In the first phase of the Pilot Project, it will cover schools drawn from KVS, Government Schools affiliated to CBSE, and the State Boards of Secondary Education at the plus two level and some private schools. Initially, the computer literacy course will consist of about 30 lectures of one-hour duration and 30 practical sessions each of two-hour duration, commencing at Class XI in the plus two stage of the Senior Secondary Schools.

The Ministry of Education, Government of India, had constituted a Committee consisting of members drawn from the Department of Electronics (DOE), Indian Institute of Technology, Delhi, NCERT, CBSE and the KVS. This Committee has been entrusted with the work of preparing details of the teacher training requirements, student curriculum and other modalities of training. This Committee decided to hold the national workshop inviting distinguished academicians from teaching institutions (including those selected as resource centres) to seek opinion on teacher training curriculum and student curriculum for the pilot project. It was expected that the various other issues related to the setting up of resource centres—funding and equipping them, and the monitoring of their utilisation of resources—would also be clarified.

The inaugural session ended with a vote of thanks presented by Dr. (Mrs.) G.R. Ghosh, Head of the Department of Education in Science and Maths, NCERT. Professor Ghosh thanked the Chief Guest, Prof. S. Sampath, Prof. C.S. Jha, Prof. Ashoka Chandra and all the distinguished guests. She also thanked participants from resource centres and other institutions who attended the programme at a very short notice.

Discussion Session

The inaugural session was followed by a brief open session in which the participants were asked to raise questions and offer their suggestions on the salient features of the pilot project spelt out by Professor Ashoka Chandra.

The lively discussion that followed included questions with regard to the :

- —identification of resource centres, their role and facilities to be provided to them ;
- —availability of hardware and software to resource centres required for training of teachers and also for use in schools ;
- —limitations with regard to curricular factors such as availability of space, utilisation of after-school time and holidays, training, adaptation of the programme for specific subject areas, general themes and vocational areas, motivation of teachers, incentives and administrative control, etc., and
- —criteria for selection of schools and role of non-government institutions.

Professor C.S. Jha and Professor Ashoka Chandra summed up the discussion. A few important observations made in reply to questions were as follows :

1. The pilot project aimed at testing the use of computers as an educational tool for improvement of quality of education. It did not aim at imparting knowledge of computer technology.
2. The emphasis in the project will be on imparting skills to pupils

and familiarising them with the applications of computers in every walk of life. It was proposed to be a voluntary, non-examination subject. It was also open to pupils of all ability levels.

3. The need for developing our own software was accepted. However, in the initial stages, we could adopt or adapt software packages from other places. In some subject areas such as mathematics and science, culture-free software were available. In the beginning, it would be desirable to introduce the computer not as a subject but as a hobby and make children play with computer games.
4. The need to support the programme by other media such as slides, films, video-tapes, etc. was agreed.
5. The resource centres had been located in institutions that had already demonstrated computer ability and possessed trained personnel to organise teacher training and also provide directions to schools. It was not possible at this stage to specify the hardware or software facilities likely to be made available to resource centres. The workshop aimed at finding out questions in this regard and generating possible answers for them. Once the task was defined in terms of curriculum for teacher training and pupils it would be easy to pinpoint what facilities were required. Maybe, as the project makes headway, resource centres will be able to locate their own requirements themselves.
6. The administrative requirements for implementation, maintenance and monitoring of the pilot project will be looked into jointly by the Ministry of Education and the Department of Electronics.
7. The need for developing courseware such as textual materials, teacher manuals, guidelines for resource centres, etc. would get priority since the project was to be implemented from July 1984.
8. As the project progresses, software based on local environment and culture will be made available. The use of regional languages will be given due place as the programme extends to all schools in rural and urban areas.
9. Non-government agencies/institutions will be associated with the programme.
10. The suggestion of using Mobile Van was under consideration.

Afternoon Session

CHAIRMAN : PROFESSOR ASHOKA CHANDRA

Mr. Bob Coates, the British expert, made a brief presentation of the developments in Britain with regard to 'Microelectronics Education Programme' (MEP). The programme was initiated in Britain in 1980-81 with the following two main aims :

(a) to help children understand the technology, its uses and its effects on society, and
(b) to encourage teachers to use the technology in improving the effectiveness of their teaching.

The programme covered all curriculum subjects and provided for children of all ages. The programme also considered the needs of children of all ability levels. In order to reach teachers all over the country MEP activities were organised into fourteen regions. The regional activities were divided into three parts :

1. Setting up of an information centre to keep teachers well informed.
2. To conduct in-service training programme for teachers in all subjects and at all levels
3. Development of curriculum, preparation of new computer programmes and other teaching materials according to the needs and the environment.

Mr. Coates briefly mentioned the achievements of the programme. The first achievement was that children began to appreciate simple devices, the logic which arranges elements to perform specific jobs. From the skill point of view children learned the fundamentals of problem solving. They could also develop further devices and teaching materials to enhance their understanding in different subjects. Secondly, children could understand how the computer works as a system and the various elements of language and operation. The programme did not emphasise that children should be trained as skilled programmers. Thirdly, the teachers could use the computer to help children learn any subject in the curriculum. They could also encourage children to explore topics, draw their own conclusion, deduce concepts from their experience. Computer-based learning could draw out deductive thinking, exploit and manipulate the knowledge for decision-making. The fourth achievement was with regard to communication and information studies. The programme could develop culture-free software. It could help children collect, organise the facts together, overcome the boring bits of sorting and lead to deductions, planning and thinking. Mr. Coates also informed the participants about the software prepared under the programme.

The talk was followed by a practical demonstration of software to the participants.

27 March 1984

Session on Curriculum

CHAIRMAN : PROF. S. SAMPATH

Presentation of Curricula

Two papers, one, 'Student and Teacher Training Curriculum' by Prof. S.N. Maheshwari, Department of Computer Science and Engineering, Indian Institute of Technology, Delhi, and the other, 'Curriculum for Short-term Teacher Training Course' by Prof. A.N. Maheshwari, Regional College of Education, Mysore (on behalf of the NCERT working group on Computer Education) were presented. Copies of these papers are appended. The papers provided a basic draft for discussions.

The framework of curriculum was generally accepted as a basis for further work. The participants made some very useful observations and offered suggestions in the discussions that followed. A few important points that emerged during discussions are as follows :

1. The need for making computer literacy programme an integral part of the total educational programme in the school was pointed out. The success depended on how best this programme would bring qualitative change in the total teaching learning process in the school. Teaching, by and large, was subject oriented and it was necessary to bring about improvement in the performance of subject teachers. Further, since the computer programme will emphasise more on learning skills and processes of learning, the need for providing facilities for the transfer of these skills to the learning of other areas was obvious. The most popular method in a traditional class was the lecture-answer-exercise-assignment method. Will it be possible with the introduction of the computer to replace this approach by a problem solving, process-oriented approach in teaching ? The computer had great potentiality for collecting and organising, approaching and inferring inductively. Will these be effectively utilised in the learning of languages and communication skills and development of inductive thinking, imagination and

independent student learning? The challenge lay in liberating the methodology in teaching and learning from a conventional structure.

2. The key role of teachers in the implementation of curriculum was emphasised. Teachers should be creative.
3. Curriculum in the beginning should not be rigid. What was required was to initiate activity in the problem oriented way and subsequently the real curriculum would emerge from man-machine interaction. We could not be too idealistic. The curriculum design should be for ordinary teachers. Further, curriculum implied many things such as time distribution, evaluation scheme, examination requirements, etc. These could not be straightaway decided without other local considerations.
4. Software should be tailored to local needs, culture, environment and as far as possible should be in local languages. Further, in due course, teacher-made softwares should be made available. It was desirable to plan a complete package utilising computer software, video-tapes, films and radio, etc.
5. To make the programmes effective it was suggested that a curriculum should not be loaded with programming.
6. Suggestions were also made with regard to the duration of curriculum and scheduling of time for theory and practicals. The availability of time during normal school hours was not feasible. As such it was suggested that after-school hours and holidays may be used for this programme. If necessary, phasing of the programme and using time available for SUPW may be explored.
7. An important suggestion was made with regard to the age requirements of the teachers. It was pointed out that beyond a certain age it was difficult for teachers to adjust to new innovations. It would be better if younger teachers were involved.
8. The teacher curriculum should be somewhat wider than the student curriculum. It should also include some technical aspects with regard to maintenance of equipment and repair of normal faults. A few good teacher training programmes may be video-recorded and supplied to resource centres.
9. Suitable proformas for keeping records, observations and teacher profiles may also be prepared.
10. The central curriculum should not be implemented rigidly in schools. It should provide common structure on format and facilitate local adaptation in the light of the teacher competence and resources available.

Meeting of Coordinators of Resource Centres

CHAIRMAN : PROF. ASHOKA CHANDRA

The session was devoted to discussions among the coordinators from various resource centres. At the outset, Prof. Ashoka Chandra pointed out that the minimum period of teacher training should be four weeks. These could be further followed up by short courses. Since teachers were available easily during holidays the programmes should be organised in the coming summer holidays. He spelt out the functions of resource centres as follows :

1. Advise, support and train teachers, both in the beginning of the programme, and later, on the job as the courses progress.
2. Monitor and ensure proper implementation of the programme by identifying difficulties and coordinating work in different schools.
3. Ensure teacher growth as a part of effective implementation of the programme, by setting up a system of communication with schools.
4. Document computer-assisted learning software and undertake its adaptation to local environment and culture. Locate and identify software packages.
5. Review curriculum continuously, help in making it oriented to local needs, resources and suggest subsequent modifications.

In the discussions that followed different roles for resource centres were further classified :

1. It was mentioned that no separate (new) staff member will be appointed for this programme. Staff already working, will therefore, be required to adjust to another type of administrative functioning. Since the implementation will also depend on how non-teaching functionaries in the school react to the programme, it was suggested that Headmasters, District Education Officers and other Administrators who supervised and controlled normal functions of a teacher in the school may be called for a short orientation.

2. Resource centres should perform promotional role and popularise the programme through local media utilising local language.
3. Resource centres should also function for development of resource materials. A compact project design conceptualising action plan may be circulated centrally. A suggestion was made to prepare booklets explaining salient features and thrust of the course for parents and the community.

   A handbook on course outline could be centrally developed. This may be later adapted to local resources and teacher competence after testing by each resource centre. The handbook should give sequential learning steps for various content areas and skills.
4. Resource centres should also monitor and evaluate the programme as it progresses. Suitable record forms and proformas to collect bench mark data, etc. should be developed centrally and made available to resource centres. All administrative problems could not be possibly handled by resource centres. The central coordination committee should identify and take up these problems such as deputation of teachers, transfer, etc. with appropriate authorities.

Afternoon Session

CHAIRMAN : SHRI Y.N. CHATURVEDI

Monitoring and Evaluation of the Programme

Professor A.K. Jalaluddin gave an introductory talk highlighting issues and suggesting the need for the setting up of a systematic monitoring and evaluating agency for this programme. The pilot project would involve about 250 schools scattered all over the country and under different types of administrative set-ups. It was, therefore, natural that teaching standards and other facilities would widely differ. To maintain coordination and progress as envisaged it was necessary that a central agency be set up to gather baseline data throughout the period of the project. This could include data on physical aspects such as number of schools, students and teachers, inputs made available, distribution of time, etc. This could be checked and assessed towards the end of the year to find out the degree of achievement for different targets. Another type of data could be related to quality outcome in the achievement of students. This may include assessment of teacher orientation, and software—its appropriateness and acceptance. Suitable tools for the purpose were required to be developed right in the beginning. This would help not only in assessing the quality of the programme but would also act as a support for improving the curriculum.

An external evaluating agency with appropriate linkages with the resource centres and pilot schools should be identified. Although the resource centres will be in direct communication with the pilot schools, the evaluating agency may keep the functionaries, who will be involved at resource centres/pilot schools in developing curriculum materials such as teachers' guides, instructional units and pupil evaluation materials, informed about the results of the evaluation.

In the discussion that followed, the need for setting up an agency for monitoring and evaluation was accepted. The central agency should inform resource centres and schools about the various modalities of monitoring/evaluating. All aspects of expenditures, capital investment, appointment of personnel, software development, etc. would be monitored. Suitable proformas for this purpose should be prepared in collaboration with institutions which have sufficient research and academic capability.

Valedictory Session

CHAIRMAN : SMT. SERLA GREWAL

The valedictory session started with a brief review by Prof. Sampath, Director, Indian Institute of Technology, Kanpur, of the activities during the past two days.

Dr. T.N. Dhar, Joint Director, NCERT, presented a brief resume of the proceedings of the workshop and summed up the main recommendations.

Valedictory Address

Dr. P.P. Gupta, Secretary, Department of Electronics gave the valedictory address. In the address, Dr. Gupta explained the relevance of the project in view of the impact of the computer in the field of technology and industry and on all other aspects of human activity. He expressed his gratefulness to all institutions who had supported the programme wholeheartedly. The enthusiasm for participation in the project was tremendous. It was becoming difficult to restrict the number of participating schools to 250. The programme had been conceived as one of the most powerful educational media. It was, therefore, necessary to integrate it with the various innovations now being initiated in the name of educational technology, such as TV, VCR, etc. He emphasised the key role of software in making the programme a success. He hoped that although in the beginning culture-free software could be used from other countries it would later be necessary to prepare our own software reflecting local culture and needs. Dr. Gupta welcomed the participation of British experts who had a very wide and rich experience in the field. He hoped that with the working arrangements that had been finalised with the U.K. Government their experience would help both in implementing the project and also in working out the educational inputs. Dr. Gupta gratefully acknowledged the contribution of Prof. Sampath who was also President of the Computer Society of India in guiding the deliberations of the Workshop on these two days. He asserted that the Computer Literacy Programme was a National Programme and could be successfully implemented with the cooperation of many institutions such as Department of Electronics, Ministry of Education, NCERT, engineering institutions, schools, etc. He hoped that the outcome of the workshop would help in providing direction and focus to the activities of the resource centres and schools in the implementation of the programme. In the end Dr. Gupta thanked Mrs. Serla Grewal, Dr. P.L. Malhotra, Prof. C.S. Jha, Prof. S. Sampath, Shri Y.N. Chaturvedi and coordinators from different resource centres and all the distinguished guests present.

Presidential Address

Mrs. Serla Grewal, Secretary, Ministry of Education, made the presidential remarks. She appreciated the speed with which the project had taken off. She welcomed the project as it satisfied the future needs of children and was forward-looking. She recalled the impact of computers and emphasised the need of orientating children about it. Children should not only be familiarised with computers in schools but should also be acquainted with it in life outside school. She was not in agreement with those who raised doubts about the appropriateness of taking up computer literacy in schools. One should not be discouraged by asking questions as to what we had not done and what was not yet completed. She expressed her happiness that there was wide willingness for the programme. Many schools were approaching for participation in the pilot project on voluntary basis. She expressed her gratefulness to all participating agencies who shouldered the responsibility of its implementation, such as engineering institutions, resource centres, Department of Electronics, CBSE, NCERT, schools, etc. She laid great emphasis on mutual cooperation of all nodal agencies responsible for organisation, teacher training and pupil curriculum. With proper coordination the various problems would be easily solved.

She welcomed the participation and cooperation of British experts. She also referred to the need for sharing the experience with all other countries who had similar expertise.

Mrs. Grewal expressed her thanks to Dr. P.P. Gupta, Secretary, Department of Electronics, Professor S. Sampath, Professor Ashoka Chandra, Dr. P.L. Malhotra, Director, NCERT and all those participants who contributed to the success of the programme.

The session ended with a vote of thanks to all those present.

ADDRESSES

ADDRESS

by

DR. P.L. MALHOTRA
Director
NCERT

I consider it a rare privilege to welcome so many distinguished scholars and specialists from all parts of the country to this National Workshop on Computer Literacy Curriculum, organised by the National Council of Educational Research and Training in collaboration with the Indian Institute of Technology, Delhi, Department of Electronics, and the Ministry of Education and Culture, Government of India. On behalf of the NCERT, the collaborating agencies, and personally, I most heartily welcome you all to the Workshop. I am indeed beholden to you for having accepted our invitation to attend the Workshop at a very short notice. I hope through our combined effort we would be able to make this Workshop a very significant preparatory step for the launching of the pilot project in computer education, sponsored by the Department of Electronics, in July 1984 in a representative sample of 250 schools spread all over the country.

It is significant to note that the initiation of computer literacy in our schools coincides with the completion of a decade in the implementation of the new 10+2 pattern of school education in the country. As you all know, the major achievements of this new pattern of education lie in the introduction of science and mathematics as major components of general education in the ten-year framework of school education and in the vocationalization of the plus-two or the higher secondary level. I must emphasise here that in spite of several organisational and resource constraints all the States and Union Territories have accepted the rationale and objectives of the new pattern of education. While the educationally advanced States have by now been able to strengthen their resource base in supporting a continuous process of curriculum renewal, the remaining States are in the process of making serious efforts to overcome the influence of the traditional curriculum. However, this major reorganisation of school education in the country has not reached the present level of achievement without encountering serious problems of implementation. Lack of adequate resources, both physical and human, happens to be the most limiting factor in our efforts to improve the quality of school education and in its quantitative expansion.

More than 35% of our primary schools are managed by single teachers and a large number of secondary and middle schools are yet to provide basic facilities for teaching. In view of this background, one of our major concerns in curriculum development has been to ensure equality of opportunity to children of diverse socio-economic backgrounds while promoting innovative measures for universalisation of elementary education and the improvement of the general quality of school education.

It has also been observed in the recent past that the quality of science education could not be improved by investing on laboratory facilities alone. Very often such facilities remain unutilised or underutilised in the absence of proper motivation on the part of school administrations and science teachers. Excessive emphasis on annual and terminal examinations and an overwhelming stress on rote learning have been found to be the main reasons for the lack of adequate teacher and pupil motivation in innovative teaching and learning for genuine understanding and development. It is, therefore, almost imperative that an educational innovation in order to be widely replicable should not only be effective in accelerating the process of classroom teaching and learning in a desired direction, but must also be equally effective in positively influencing the organisational behaviour of the school system.

I have narrated this background only to highlight the context in which we have decided to implement the pilot project on computer appreciation-cum-education in the selected schools.

You will be happy to know that the Government of India have been extremely careful in identifying schools for participation in the pilot project. This exercise is being done in close collaboration with the State authorities and other agencies concerned with school education, including the Kendriya Vidyalaya Sangathan, Central Board of Secondary Education and NCERT. An appropriate mix of schools under different managements, under the overall technical criteria recommended by the Electronics Commission, is sought to be achieved. Resource needs of the selected schools may therefore vary considerably.

Of late, several studies have been published on the nature and scope of computer education in schools and also on the broader issue of the relationship between technological change and educational development. The idea of using microcomputers in schools is not altogether new. The philosophy of programmed instruction, which became popular in the 1960's, was in fact the intellectual forefather of computer assisted instruction (CAI). The intellectual environment that gave rise to the first generation of CAI systems in the early 1960's was strongly influenced by the programmed instruction movement, which was based on a science of learning or, to be more precise, self-learning. Initially, CAI was seen as a direct continuation of the mechanical teaching devices which were designed for automatic testing and scoring. By 1970 it became clear that the conventional CAI exploited only a small part of the computer's power by restricting itself to electronic page turning. Today, a microcomputer in a school has been widely accepted as a tool for problem-solving and self-learning.

The developments in microcomputer hardware and software have been so fast during the last 6-7 years that the role of microcomputers in enhancing the intelligence of very young learners and in making knowledge more operative and dynamic is clearly visible. Besides the prospects of a rapid decline in the cost of the hardware, there are overall welcome aspects in the field of software for educational microcomputers. Broadly speaking, a well designed and relevant software package may bring about a qualitative change in the attitude of teachers, principals and educational administrators in the present context of our school education where textbooks and a content-dominated examination system overshadow the real learning and development of pupils. Well chosen software, suiting our situation in the classes, can enable educators to promote children's thinking and reasoning.

In this sense, the use of microcomputers in schools and in the training programme of teachers has an important affective role liberalising the process of education, in addition to its role in accelerating skill development.

In almost all the countries where computer literacy courses have been introduced, the most important gain has been observed in terms of a perceptible change in the classroom behaviours of teachers in favour of greater flexibility and innovativeness in lesson-planning and self-learning. Parallel to these positive experiences, the leaders of many pilot projects also had to face numerous negative factors. The most complex of these negative factors is the difficulty of integrating new tools into an existing curriculum. Many of them found it was extremely difficult to procure software and other computer materials that were educationally sound and developmentally appropriate for a particular group of students. In most cases, the materials that were easily available often did not fit into the curricular plans of the users. Moreover, many of the skills that computers taught best were not included in the existing curriculum. Since there was no room for adding on to the existing curriculum new skills and content had either to replace existing material or be ignored.

There is also a growing apprehension among a group of educational philosophers that an excessive interaction with and dependence on the computer in the early stage of education may promote a highly structured and linear thinking among children, which may adversely affect their emotive development and holistic vision. This aspect is particularly important for us in India, for our cultural heritage and ethos always promoted a balanced world view, with greater emphasis on higher human values as a guiding force in cultural renewal in contrast to the emphasis on information processing as the basis of such renewal.

Another factor that kept schools from becoming computer-literate was the inflexible work-day of teachers, which did not allow them time to experiment with new machines, to invent new techniques, to search for appropriate software, to read journals and books about computer based instruction, or to perform a series of related tasks. Only a few highly motivated teachers who participated in a pilot project did manage to find time to engage in such activities—particularly when they were able to take computers home on weekends and holidays.

I cited the above instances only to highlight the fact that developing a computer-literate school is a complex process and there is an urgent need to systematically plan every step for the implementation of our pilot project so that appropriate steps could be taken immediately to overcome the known practical problems of failure.

I firmly believe that the considerations involved in the designing of a computer literacy course for students and a training course for teachers cannot be completely delinked from the operational and management aspects of the project. As the operational aspects of the project would be explained in detail by our distinguished colleagues from the Department of Electronics, I would like to very briefly state at this stage some of the issues related to curriculum development and implementation in this new area of our pedagogic interest.

The proposed computer appreciation-cum-education course will be primarily available to the secondary level students in the selected schools on the basis of voluntary participation. The course duration has been tentatively recommended as 30 hours of lecture and 60 hours of practical experience. As a school has on an average 30 working weeks, the average number of contact hours per week for a student comes out to be 3, which is equivalent to 4 periods of 45 minutes' duration. The course, therefore, might have to be spread over a full academic year and the participants of the course would be expected to be highly motivated so that they would be able to sustain their interest even on the eve of examinations.

As we all know, student motivation to participate in any optional course depends either on its relevance to the terminal examination or its recognition in the job market. The first aspect of the course is distinctly related with the general or universal function of secondary education, and the second aspect may be characterised as being preparatory to professional training or occupation-related to specific skills. From the point of view of a prospective participant, the proposed course should either enable him to learn his regular subjects better or to acquire some additional skills which might be treated as a premium either in the job market or in higher education.

It is, therefore, obvious that there is a wide scope for the introduction of different types of courses with a given hardware and software facility although initially the project might be launched with a single course outline in view. However, if such a course is not designed to transfer generalisable learning skills of immediate relevance, there might be a growing demand to link the computer appreciation course with the existing curriculum in the pilot schools. Hence, there is an urgent need to review the available software in the light of their relevance to the existing instructional materials in the pilot schools.

As the technical expertise required for identifying the expected learning outcome of a computer software in relation to the existing school curriculum in behavioural or structural terms may at present be available only in a few agencies like NCERT, there might be a need to take up this responsibility centrally in the initial stage. Subsequently, this responsibility may be transferred to the resource centres and, if possible, to the level of the school teachers. This is also important due to the fact that all the schools selected under the pilot project do not follow the same curriculum or medium of instruction. In contrast to the involvement of students in computer literacy curriculum in the affluent countries, where individual students and parents have easy access to personal microcomputers, the thrust of computer literacy should initially be on teachers' involvement and development in the context of India. It is only through a well thought out teacher training programme that we would be in a position to develop our capability to initiate supportive projects for the development of indigenous software with the active participation of teachers and subject specialists.

The resource centres in computer education have the added task of intimately acquainting themselves with the curricular concerns and constraints at the secondary and higher secondary levels of school education, in addition to the training of school teachers in the effective use of the new educational technology. Nothing other than a true spirit of mutual learning on the basis of equal participation among the resource persons and concerned school teachers can be effective in making the pilot project a viable one in terms of indigenisation of this new technology in India.

The Department of Electronics, the Ministry of Education and Culture and the two major back-up agencies, namely, NCERT and IIT, Delhi, have made a humble beginning by developing several background documents giving an indication of the direction in which the Workshop is expected to concretise the curriculum outline. I hope you will have an opportunity of going through these papers by tomorrow morning when we propose to take up some of the issues raised in these papers.

I am also happy to announce that a team of British experts in the field of computer education would join us in the next session and demonstrate the computer hardware and software used by them in the U.K. and share their experience with us. On behalf of the sponsoring agencies, I would like to extend a hearty welcome to the members of the British team.

I would once again like to express my sincerest thanks to Professor Sampath, Professor Jha, and other distinguished participants and guests for joining us in this National Workshop. I am also grateful to the Department of Science and Mathematics, Professor Ghosh, Professor Jalaluddin, Mr. Saxena, Dr. Mathur, Dr. Maheshwari and Dr. Gupta for taking great care in organising this National Workshop.

ADDRESS

by

PROFESSOR S. SAMPATH
Director
Indian Institute of Technology, Kanpur

The electronic computer is the outcome of one of the most remarkable intellectual ferments to take place in human history. A U.N. document which deals with the role of computers in development identifies the computer as an amplifier of the human intellect. It makes the following points : "In the process of being introduced to carry out a task, the computer brings about a reassessment of the whole way that the task should be done. In fact, it often brings about a re-evaluation of why the task is being done. This examination of the ends and means is as important as bringing in the computer itself".

About 25 years ago, Professor Herbert Simon of Carnegie-Mellon University, USA, who wrote a programme called the 'Great Problem Solver', made this observation :

"There are in the world today machines that think, that learn and that create. Their ability to do these things is going to increase rapidly until in the visible future, the range of problems that they can handle becomes co-extensive with the range to which the human mind has been applied".

I wish to refer to a few examples of what may be called intellectual discoveries by the machine. A programme called 'Logic Thrust' is known to have produced a new solution relating to the proof of a theorem in mathematical logic, which brilliant mathematicians like Bertrand Russell and Alfred North Whitehead had missed. A programme, designed at Carnegie-Mellon called BACON was set to look for pattern in scientific data and, on its own, it 'discovered' a rule of planetary motion first established by Johannes Kepler. When this system was fed with all the facts that were known in the field of chemistry in 1800, it deduced at once the principle of atomic weight—a feat which human scientists were able to achieve only after 50 or more years of strenous effort.

A decade ago, few would have believed that there would be a $ 100 machine playing chess better than 95% of the population; or a set of programme that would interpret cardiograms better than most doctors; or a programme that would unravel prospect for minerals.

Says Marvin Minsy, computer specialist at MIT, USA, "It won't be long before we have in our midst machines capable of solving any mathematical problem posed to them. Programmes will be written which will enable them to react reasonably to significantly complex situations".

The computer, aided by VLSI-technology, is ushering in a second industrial revolution. The real revolutionary aspect is not the number crunching capability of the computer but its ability to be a perfectly general symbol-manipulating device Such a system with the basic capabilities of reading, writing, erasing, comparing and branching with respect to pattern is a necessary and sufficient condition for the mental process of thinking.

There are striding advances taking place over the whole gamut of computer technology. In the domain of large systems—now being referred to as main frames, there is a continuing thrust to exploit technological advances in microelectronics and introduce innovation in internal-systems architecture and associated memory system. Central processes are being designed in new ways to produce more power at the same cost and architectural changes aim at deploying the raw power more effectively. Memory systems, highly ingenious, are under development and in use. While the performance capabilities of the newly evolving systems are much as to stagger the imagination, the complex computational requirements of today in several areas of application in science and technology cannot be adequately met without their use.

Mini-computers, since their advent in the early 60's, have grown in number and versatility. They came in and removed cultism from the profession—by moving out the inflexible electronic assembly from its air-conditioned sanctum and making it take its place in the field of use as a flexible, programmable device or as system-component depending on the needs of the situation. The mini-computer puts the person with the problem in direct contact with the machine. It has helped to stimulate new concepts in design, manufacture and marketing. It is widely used in scientific research, in industrial and business environment, in chemical laboratories and hospitals, in communication technology and education.

The microprocessor-chip making its appearance at the commencement of the last decade, heralded a quantum jump in the technology of mankind. The development of this device has the force and significance that we associate with important milestones in the evolutionary history of the human race—and would rank with the fashioning of hand-tools or the invention of the steam-engine. A tiny chip, by virtue of the electronic that goes with it, has begun to make a greater impact on society than any other single device that we may name. Computer systems, based on their use, can be tailored economically to bring computer-capability to a host of tasks where the use of a mini-computer—let alone a big machine—will amount to "over-kill". It lays bare the myth that computer is a site that is accessible only to a privileged band of users. No doubt, prospective users will have to imbibe a variety of skills. The required skills are within the reach intellectually and in terms of cost, of anyone who is seriously interested in making the effort. The chip would be extraordinary enough if it were only low cost, compact electronics—but its ability to embody logic and memory gives it the essence of human intellect. Like the mind, the chip has virtually infinite application and much the same potential to alter the life style fundamentally.

Personal computers—referred to as user-friendly systems—have grown in the last few years from being vehicles for video games and word processing into machines rivalling minds in computing power. There is growing emphasis on the use of sophisticated software and graphics. The user is no longer constrained to access the computer by typing cryptic code words through a key-board. He can do this now by printing symbols on a screen. A variety of different approaches combining graphics software and hardware are emerging : screen cursors controlled with a joystick or "mouse", touch screen, graphic "windows" and programmable or "soft" keys. There is also increasing stress on computability between personal computers—especially with respect to applications—software and the development of operating systems as industry standards.

The growth of microprocesses and personal computers, notwithstanding main frames and mini-computer, continue to make substantial advances. Chip manufacturers produce newer and newer concepts to accomodate the growing hardware needs. Not only are super computers becoming more super; super minis and super micros are showing the same trend. Underlying all this is the quest for higher and higher computing speed.

In situations where the economic penalty of computer failure can be severe, users demand systems that offer self-detector and diagnosis of hardware flows and self repair together with fast software recovery after failure. These fault-tolerant computers call for the generous use of hardware but, with the continually decreasing cost of integrated circuits, this poses no problem.

A super-minicomputer model of today priced at $ 10,000 is one-sixth in cost of the 1973 machine and operates at seven times the rate. Typically the 1984 minis deliver, at the same price, five times the performance of the 1983 models. The focus is our standardisation, care of use and general computability. The 32 bit minis are taking over many of the applications now assigned to main frames—such as handling customer services in banks, collection of data from satellites, analysing aircraft structural stress-test results and managing large-sized inventories Multiple processor super-minis, on the horizon, promise many new applications.

Microcomputers are moving down in size and price, approaching the personal or desk-top computer. There is a 32 bit microprocessor based work station that sits on desk-top. Another system uses a 16,32 bit microprocessor with the UNIX-operating system, 320 Kilobytes of semi-conductor and 15 megabytes of hard-disk storage besides high-resolution graphics colour display and word processing and finalise spreadsheet application software.

Super-microcomputers offer the capabilities of mini-computers. These are distributed systems in which many terminals—as many as 1000, each containing its own microprocessor chip are linked as a system. Hardware for data-storage and processing is distributed among the terminals. Net-working software allows the terminals to communicate. From the user's point of view, the data and the peripheral resources of the entire network appear to reside in the user's own terminal. The network appears to the user to be a single machine.

Powerful new skills and systems are being developed for use in computer aided designs. Innovative design tools for electronic systems are becoming available, *e.g.*, the gatemaster used in the orsip of large system based on gate-arrays which replace logic circuits with discrete component in many applications, reducing cost and power requirements and increasing reliability.

Knowledge system, based on artificial intelligence software capable of giving expert advice or analysing complex information within particular limited domain are becoming commercially available. As knowledge based systems are becoming better known and more cost effective, a great deal of effort is going into building software tools rather than in speeding up their development. There is growing interest in the problems of computer security.

Many organisations are engaged in creating a network of communication highway for data and also for image and video-information. There is a significant technological effort being made to develop the ability to send and receive 'currents' that can be mixtures of several nestia and draw upon global information repositories. The tangible benefits flowing from these developments will be the substitution of electronic information flow for human transportation and the establishment of officers in the homes of the professionals Voice-mail system and network-based conferences are newly emerging forms of communication. Local and global networks promote the design of machine for highly optimised shared function such as the recognition of speech, the information and the efficient storage and retrieval of information.

The computer is more than just a productivity engine. It is well on its way to becoming a responsive personal companion to people at home as well as in the work-place. The innovation-challenge is not just technical. It lies in matching the broad spectrum of new technologies for service to the informational, educational and cultural needs of people constituting contemporary society.

Speaking of the dividends from computer-based individualisation, Professor Weizenben of MIT, USA points out the following :

"You care about skiing or coin collecting. Your weekly magazine will be able to bring you a lot of ski and coin news in addition to general news during the same week. Your neighbour's copy of the same magazine will have a lot of news that you do not have about fishing and stamp collecting if that is what he cares about. For the computer these requirements pose no problems."

The examples sound like an information function appropriate to members of an affluent society but the ability of the computer to provide personalised information of the type that people aspire for, comes through clearly.

I recall reading an article in 'New Scientist' a few years ago, which presented this imagery of a computer at home :

"Suppose you had a filing cabinet that not only held more documents than you have on your desk and could show you exactly the one that you would normally look for. Suppose it could also produce a number of other documents dealing with the subject which are relevant and will soon require attention. Suppose further that, if the matter related to a costing budget on tax situation, the filing cabinet came with a series of possible steps that might be taken to deal with it, based on a detailed knowledge of tax and interest rates. Suppose that it produced a copy of the relevant document readily typed together with a neatly typed letter to the concerned people. Suppose it is also able to keep a record of your daughter's school notes, together with reading lists in various subjects indexed by pages and paragraphs. And it had a list of the addresses and telephone messages of your friends, associates and relatives and would dial their numbers for you on request. What would be your reaction ? Most people's response would change from "What can I do with it ?" to "Where can I get it ?" And this, even before taking into account many other chores that the machine would be capable of monitoring like all the doors and windows of the house and notifying the police if a burglar tries to force an entry, giving you a game of chess, teaching your son arithmetic or a language, and making coffee for you later on Sundays than on other days of the week."

It was stated that such a machine could be put together for a net cost below £ 5000. The break up of the estimate was : 170 Mbyte floppy disc with control for £ 2000 ; a microcomputer for £ 1000 ; a dairy-wheel type printer for £ 1000 ; a page-print for £ 500 ; a video colour set for £ 500. Buying these and putting them together will merely have a non-functioning lump of hardware on our hands. To produce the software, to run all the tempting applications referred to could cost as much again in terms of the computer programming effort. In the intervening years, technology had advanced : and costs have come down.

A doctor in Vienna, a cardiologist, installed in his outer office a mini-computer which took care of the preliminary routine queries that are usually put to a patient and elicited a series of answers The information was processed and made available to the doctor by the time he saw the patient. Looking at the symptoms, he would put a few more questions and order appropriate investigations. The course of treatment and the results achieved were put into the memory bank of the computer; and these served as aids in dealing with new cases. The doctor states that, with the computer aid, his success in diagnosis and treatment increased significantly. After two years of this experience, he issued a questionnaire to his patients which contained many open-ended questions : "If you became ill again, or if someone for whom you cared has to be treated, would you recommend :

(a) a doctor, or
(b) a computer ?"

He records with satisfaction, that in the majority of cases, the answer returned was "A doctor who has a computer."

A few years ago, Marvin Minsky expressed his conviction that it will not be long before we have in our midst computers with the general intelligence of average human beings. And he continued that when this happens, the machine will begin to educate itself and will soon reach the genius level.

One bit per second has been estimated to be the safe upper bound for the amount of information that can be committed to long-term memory. This means that a man who absorbs information for 16 hours a day over a life-time of 70 years, would store 10^9 bits. By coincidence, there are 10^9 neurons in the cerebral cortex. This order of code-store capacity and the density of optimal order to make one of it are well within the reach of the modern computer system. The interesting point is that it would take only a few minutes to transfer 10^9 bits of information—the life-time experience of an individual—from the memory of one computer to that of another using currently available techniques. It appears therefore that it would be far more easy for computers to bootstrap themselves on to the experience of other computers than it is for a man to benefit from the knowledge acquired and stored by his predecessors.

A few years ago, a British expert expressed his reaction to the revolution triggered by the microprocessor in these words :

"It would be nice to be able to say whether in this device we have an Alladin's lamp or a Pandora's box. I am personally inclined to think that it is neither but I am not so sure."

According to Professor Donald Mckay of the University of Keel, "There is a real danger that we may be led into abdicating into computers a moral responsibility and a psychological involvement in our own fates and, faced with the competition of these fantastic machine, we may despair of making our own intellectual effort and sink into trivial and self-indulgent activities"; on the other hand, we have Isaac Asimov stating the following :

"We have already reached a stage where the problems that we must solve are insoluble without the aid of computers. I do not fear computers, I fear the lack of them."

The role of the computer in the educational scene has assumed crucial significance. The impact that the computer makes on the educational process is so great that we are called upon to redefine our nature of what constitutes an educated person. Till a decade ago, only a few professors and specialists and students who had extensive data to process or complex computations to execute mastered the awkward programming language necessary to operate the computers. The availability today of personal computers with programmes that can be accurately and swiftly applied to both computational and text-processing work has profoundly altered the situation. The microcomputers get linked to the central main frame facilities. In advanced countries, plans are being made to equip every single student with a micro. Microcomputers are bing introduced into the secondary and elementary school levels, the extensiveness of the operation being limited only by the cost involved. It is estimated that by 2000 A.D., in the industrialised countries, 50% of the work force will be working with computer terminals. Every person who is being educated has to acquire computer experience. There are those who see data-processing as a tool that will let us do better what we are doing now. This amounts to a technological transformation, and there are those who regard it as the basis of a new 'information society'—this is a conceptual change. Says Paul Starr, Professor of sociology, "The microprocessor opened up a radically new possibility for the use of computers. Other developments, new, unforeseen, may also change ideas and expectations. But even with what is available or on the horizon, it is clear that the new technology can contribute significantly to scholarship science and the circulation of ideas, if we can put aside prejudices about computers and exploit new possibilities as a medium of culture as well as information."

Says Stephen White of the Alfred P. Sloan Foundations :

"What the computer has done is to provide scope for analytic skills that never before existed and in so doing it has altered the world in which the student will live as well as the manner in which he will think about the world."

He urges that the analytic skills of applied mathematics, along with technology and the elements of computer science, be made a central part of the undergraduate curriculum.

Donald Kreide, Chairman of the Mathematics Department at Dartmouth College says :

"Computers permit a marriage of pragmatic skills and theoretical structure that has eluded teachers for generations. Some powerful processes for solving equations were rarely used because they were impractical for pages and pencil method ; as computer algorithms they give students new insights into the fundamental concepts involved."

As teaching methods are changed to take advantage of computer capabilities we can expect that educated people will become more sophisticated mathematically. Another specialist in mathematics, John G. Kemmy says :

"The computer's single most important impact on education is allowing the students to participate more actively in the educational process. In much of education, the student is a passive absorber of knowledge and there is only an occassional opportunity to work out a 'canned' exercise. When spending hours at the computer terminal becomes a routine part of education, the student will be an actual participant, able to initiate changes and influence the direction of his or her education."

When the computer is sought to be introduced into every sector of the educational framework, there are hard questions that call for answers, such as these :

* Are educated persons going to be mainly processors of information ?
* Is information processing really the basis of learning ?

It is a truism that the best information and the most powerful techniques cannot give us values. Equally, values are lacking in education now.

* If the emphasis is heavily on quantitative skills and computer-based techniques, will humanistic questions get shifted to the periphery and is such a shift desirable ?
* While computers help to bring about scientific and technological improvement, are they of much use in tackling complex political decisions, moral issues, artistic creation and aesthetic judgement ?

Technological change will have intellectual effects only in proportion to its availability to a large number of people.

The purpose of the exercise that we are embarking upon in this Workshop is to develop a blueprint for action to introduce computers to our senior high school students on an experimental basis

The focus of attention will be on the course, both in terms of classroom instruction and supporting laboratory experience, that will adequately serve the purpose in view. The teachers in the schools who will handle this have to be identified, motivated and trained. Hardware and software will have to be made available to all the participating institutions in a meaningful time-frame. For the successful implementation of the pilot project proposal, the resource centres will have to be equipped and organised.

There is no wisdom in spending time and money on re-inventing the wheel. We should receive knowledge and information from outside. Our skill would lie in adopting it or adapting it to suit our conditions and requirements. We have our aspirations but also many constraints. We may have the capacity to design and build all the hardware that we will need to cover the school programmes. We have to put large teams of people to work to develop programmes appropriate to our environment to get the best returns from the equipment that will be made available to the schools. Computer professionals and the teaching community in the country will have to work together in an orchestrated effort. We cannot afford to lose time on planning the preparatory work on a totally indigenous basis. The dimensions of the project are such that, as it evolves, massive contribution from within the country, both in terms of the hardware and software components, will have to be generated. What is of crucial importance is that with a sense of commitment to the overall philosophy of the programme we take steps on the basis of current available knowledge and expertise—accepting it without reservation from those who have background experience of work in this area for many years and have demonstrated successfully the validity and efficiency of the same in their own environment and who are willing to extend their best cooperation to us as we stand on the threshold of a new chapter in our national educational endeavour. On behalf of all of us interested in the forward movement of education in this big country of ours, I welcome the offer of help from the Government as well as several agencies in the United Kingdom, which if seized upon at this critical juncture, will enable us to telescope a decade of their experience into a period of a year or so in our environment.

Monneth Boulding, the noted economist, has made this interesting observation :

"The spectacular advances that have taken place over a small segment of the world should not blind us to the fact that, over a much larger segment affecting the human race, the intractable problem of today is not how they will cope with technology that is advancing too rapidly for them but can they advance technology rapidly enough to fulfil their special requirements."

C.F. Powell, the eminent British physicist, who was moved by compassion for the poorer countries of the world, gave them this piece of advice :

"In the long view, it is most painful and will be very expensive to have only a derivate culture and not one's own with all that the latter implies in independence of thought, self-confidence and technical mastery."

In developing the computer-in-school programme and carrying it forward, as a cardinal element in our national policy in education, we should pay attention to those steps that will ensure for us independence of thought, generate self-confidence and ensure, in the ultimate analysis, technical mastery over what we are doing.

As the work progresses through the decade of the eighties, it is incumbent on us to perceive the implication of the changing profile in electronic technology in general and computer technology in particular. It will be in our national interest to present a coherent response to the challenges that have surfaced with the silicon chip. Industrialised countries deal with the problem in their own way. The complexities posed to us have a significance that we should consider carefully, and we should make our response in a thoughtful manner. We cannot avoid involvement with sophisticated technology unless we wish to isolate ourselves from the mainstream of the advances taking place in science and technology. The only way we can survive as a viable member of the community of nations in a highly competitive world is by acquiring familiarity with an area of sophisticated technology and taking steps to exercise autonomous control over it. We should make the best use of the resources available to us and optimise our movement on the pathways that will take us to our perceived goals. We cannot come to grips with our problems in the field of education, in management or in any affair without the use of modern concepts, strong analytical procedures and advanced computer techniques.

Two and a half millennia ago, the Chinese philosopher, Confucius, said :

"The essence of knowledge is having it to use it."

The electronic computer—the outcome of human ingenuity at work—is here now, through acquisition and dissemination of knowledge, to help us in translating this old dictum into reality in today's condition.

With these general observations, I have great pleasure in inaugurating this National Workshop on computer literacy and wish the participants success in their observations.

The British Microelectronics Education Programme*

The purpose of this paper is to outline the main activities of the British Government's "Microelectronics Education Programme" and to explain a little of the pedagogy which is behind our present use of micro-computers and microelectronics in British schools.

I will begin by describing how the Microelectronics Education Programme has been set up and organised, and then will describe our present thinking about the types of materials and the various methods of teaching that have evolved through our experiences in using microcomputers in schools.

In 1980 the British Government announced a project for education to meet the challenge of the new technology. Richard Fothergill was appointed to lead what has become known as the Microelectronics Education Programme or MEP. While initiated by the Government through the Department of Education and Science and receiving its funds from it, the Programme has been given a relatively free hand to approach the problems in its own way, and that sense of independence continues to be very important in encouraging teachers to work closely with us. After a preparatory period the main part of the Programme got underway in April 1981. MEP formulated two main aims to guide our decision-making for the activities we were to initiate :

(a) to help children understand the technology, its uses and its effects on society, and
(b) to encourage teachers to use the technology in improving the effectiveness of their teaching.

This means that all curriculum subjects will be affected by our activities, not just science and maths, of course, but also history, geography, music and English and many others too. Likewise, the Programme is providing for children of all ages, from five years old to 18. Indeed the five to eleven-year-olds are some of the most responsive of all.

* This paper, prepared by Mr Bob Coates, a member of the visiting team of British experts, was circulated among the participants to give the background of the computer education [illegible] on the British [illegible]

Therefore Microelectronics Education Programme is concerned with meeting its aims in all subjects of the curriculum and with children of all ages. In addition, it must be emphasised that it is also concerned with children of all abilities. As we are not concerned solely with turning children into bright computer scientists—we are not targetting our work on the clever children alone. Rather, this is for all children, for all are going to live in a world influenced by this new technology and they all need to adjust to it. It is also true to say that computer technology can bring out abilities, interests and enthusiasms which have been ignored by other areas of study, particularly in work with the technology itself.

There are over 400,000 teachers in Britain, and the question we faced was how to reach them all and enable them to participate in the work of the Programme. You may be aware that in Britain whilst there is a government department which gives guidance on education, the actual schools and teachers are organised by 109 local authorities, each with an independent viewpoint. With their cooperation (a word you will hear many times in this paper), we have organised them into 14 regions for the purposes of the Programme. This has given us the opportunity to get closer to the teachers in every part of the country for there are MEP activities scattered around in every one of these regions. Thus, the innovative strategy that we have adopted is based on encouraging teachers all over the country to join in a campaign of action. Many are working directly for the Programme, while others are using its materials or taking part in training courses. All have a national direction, amended locally to meet the particular needs of the area in which the teachers live.

More of this in a moment. Thus the strategy is based on an almost even division between activities that are initiated and controlled nationally by the directorate of the Programme and those that are operating in the regions to a nationally set list of aims, and monitored and coordinated by the same national leadership. To make this succeed, it requires a coherent plan and a cooperative approach.

The regional activities are divided into three parts. First, there is the Information Centre with staff to issue newsletters, show visiting teachers equipment and a wide variety of teaching materials in many media, help them over their problems and give them instruction, but above all keep them well-informed about curriculum developments and new software and devices in their subject areas.

Secondly, there is an in-service training programme for teachers in all subjects and at all levels. This Programme is divided into four domains which I shall describe later, and in a typical year of operation, over 20,000 teachers have been on the courses offered. These range from one-to tenday courses. Each is run in the region by regional staff so that local needs and interests are covered but the main elements of the courses are planned and developed by national coordinators. The aim is to concentrate on teachers in the regions who will become trainers themselves and then go on to train their colleagues—so that the whole approach cascades down from the national initiative to the classroom itself. It is difficult to account accurately with this method of training but a rough estimate suggests that over 70,000 teachers will now have met some training from this approach. As for the regional staff, they too go on regular updating courses to keep them abreast of the latest developments and new materials.

The third of these regional activities is curriculum development, the preparation of new computer programmes and other teaching materials, again arranged to a clear national plan of needs. This builds on the natural skills of the teachers and advisers in the regions who know what they want in the classroom, and thus there are more small groups of people involved in MEP work and generally supporting and spreading its message around the country. This increases widely the number of educationists who are cooperating with us to ensure the work succeeds

Each of these three areas of activity is mentioned in the national project as well. Thus we provide central information in newsletters and on electronic systems like our word processor discs which go out for our word processor network. Each of our regional centres has a Diamond word processor which can link through the telephone system to the others. We also use an interacted Electronic Mail service. This standardisation means that all the centres can share information, exchange discs of data-bases and make use of regionally produced information sheets, which they can personalise and print without major retyping. In addition, MEP has many pages on Prestel, the national viewdata system which schools are increasingly able to access through their computers.

For in-service training, we have a considerable project being prepared by the Open University. This will generally reflect much of the in-service programme and will be particularly valuable for those who find it difficult to attend courses or who are not very happy about attending them. The national software development units are now well established, and more are being created. They produce large numbers of computer programmes, again to a national plan of work, and they reach very high standards of quality and classroom value. The important point about all these programmes is that they are carefully planned with teachers much involved so that they fit the actual classroom needs.

Let me turn now to the coverage of the Programme and also its products to date. I am going to do this by talking about each of the domains in turn, but before doing so, let me re-emphasise the importance of the teacher-training aspects. These materials and devices do not work to their maximum effect unless the teachers using them are trained in their value within the classroom situation. This is the conclusion from all our experience, and it is the reason behind all our emphasis on careful teacher training. One further point – all these domains do have overlaps with each other ; but that is not a difficulty. It shows clearly the full curriculum pervasiveness of the technology and reflects also the well-established truism that one can approach a given piece of knowledge from several directions.

The first domain is electronics and control technology. In our view, all children must have some experience and understanding of this new technology so that they can deal with it in their future lives. This can begin effectively at 9 and 10 years of age, so that children begin to appreciate simple devices, the logic which arranges elements to perform specific jobs, and create them for themselves. This 'microelectronics for all' approach has led to some very exciting classroom work. Some are theoretical through filmstrips, simple kits and videotapes, but children really get involved and reach understanding when they start making items. Some approach this through breadboarding with children knitting together circuits that work. Others start from carefully planned boards with inputs and outputs that the children can work on experimentally. Each leads to further understanding of the different ways in which the various elements can be linked to achieve different results, all in the process of using programmable devices to achieve particular controlled results. The end product may be traffic lights or it may be a robot arm, but the process is the same in both. From the skill point of view, the children learn the fundamentals of problem solving.

With this as a basis, children may choose to develop further knowledge of electronics and control, and further devices and teaching materials have been developed to enhance that work. On the other hand, they may wish to concentrate on other science and technology subjects.

Is it engineering and design ? A computer programme through which the children can design a shape, and then the computer can control a simple lathe and cut that same shape out of polystyrene.

Is it physics or chemistry ? A new laboratory instrument which merges many separate measuring, monitoring and controlling devices in one to record and replay many experiments in a modern way and help the children draw real scientific conclusions.

Is it biology ? Devices to monitor and measure temperature, humidity, movement and chemical change to reveal insights in the science of developed materials which are specially designed for [illegible] purposes which can be used at any age. For it is already clear that teachers of many subjects find that word processing for themselves, and for the children they teach, can be very useful. Not only are we interested in the full keyboard as an input system for word processing, but we also want children to experience and use other methods of manipulating text, one-hand keyboards for example. It is clear that the standard typewriter layout will be only one among many input systems in the future, and children must be prepared to accept these changes without qualms or hesitation. Together with all other aspects of electronic communication systems which children will find a major feature of their future, this forms one part of the work of this domain.

The other part, and in many ways some of the most significant aspects of the whole approach of MEP, is the area of information studies. You will all be familiar with information retrieval systems, and the Programme has fostered several approaches. These range from [illegible] for young children to more sophisticated work for the older ones. Much early learning is spent on the collection, organisation and presentation of factual information, and information retrieval systems are delightful and exciting ways in which children can get their facts together, overcome the boring bits of sorting and come rapidly to groupings which can lead to deductions, planning and thinking. In our opinion, this introduction can start at even four and five years, particularly with pictorial presentations of the results. When they get older, the systems have to be more complex, but then they are dealing with larger and more sophisticated bodies of information and looking for deeper insights and understanding. A data-base of a census can be very large, but the information that children can deduce from its rapid sorting can reveal very interesting and educationally useful knowledge.

This is still only the beginning. Large data-bases are increasingly on tap at the end of a telephone line. While each might have its own protocols, the principles of access and search are the same and these are what children need to appreciate so that they can cope with developments in the future. Their microcomputer is the terminal from which very large quantities of data can be accessed and explored as necessary. But the core of this work is the nature of information itself. What is it? How does it arrive? How is it created? What questions do we ask in order to get what we really need? Most important of all, what do we do with it when we have the information? These are the fundamental educational issues and we are now working hard on materials that help children work towards the answers. As will be clear to you, these are issues that affect every subject in the curriculum, and so the work we do must help in each and every discipline. In the classroom itself, the changes will be profound, for it is not the information-giving role that will be the main purpose of the teacher but rather the information-using aspects. This is a change to the core of our understanding of the purposes of education.

Those then are the main domains of the Programme, each approached broadly and affecting all aspects of the learning environment and all parts of the curriculum. One further sector is receiving much attention, and that is special education. I had better explain what is meant by that. A number of children are slow learners or may even be mentally backward, and a small number suffer from physical handicaps, blindness, deafness or muscular problems. All these collectively are educated through special education schools or units. Programmes for them work at a lower level of sophistication, helping them to practise skills and reinforce knowledge that they have gained. A number of programmes have been developed for these children, and some of those aimed at younger children can be specially adapted. MEP is also working with some simple devices to try and help these children manipulate and work in their environment. This is important if they are going to be able to fit into normal society and communicate comfortably and naturally with other people. The power of the products of the technology can be very helpful indeed in this area.

The approach to special education is the same as the rest of the Programme. We have information centres called SEMERCs that keep teachers informed and provide exhibitions of range of appropriate materials. They are also involved in stimulating cooperative work between the teachers. There are also teacher training activities which help to brief the teachers and keep them up-to-date with the latest developments, and also there are projects throughout the country where materials and devices are being conceived, created and tested in the classroom. The number of children who need this help is not very large, but the effect on them, their ability to communicate, work and join in with the rest of the society is profound.

I am sure you will have noticed that up to now I have hardly mentioned equipment. Only in the electronics domain has it figured significantly. The theme of the Programme has been to answer the questions that have been posed by educational needs, the requirements of teachers and the curriculum initiatives that have underwritten them. However MEP has not ignored the equipment side, and by working in cooperation with another part of the Government, the Department of Trade and Industry, it has encouraged the distribution and use of computers.

Three major schemes are now complete or underway to help schools purchase equipment, all of them involving government funding of half the price while schools have paid the other half. Only one computer or peripheral system has been on offer to each school in this way and they have been able to choose from two or three British machines Research Machines, Acorn/BBC and Sinclair, all of which are available throughout the world. The programmes we have written work on these machines, but many are also available on Apple and Pets. Our ethos has been to write for one machine and rewrite for the others so that the programmes take advantage of the particular specifications that each offers. In [illegible] each of these computers has proved very successful and now networks are being established between groups of them. While the government offer only referred to one machine, the impact has been very [illegible] considerable. Schools for the 11- to 18-year-olds have at least five now and several have 20 to 30 computers, while the smaller schools for the 7- to 11-year-olds have one to two. Considering that resources for schools are limited, this is a very rapid uptake in a period of about only two years. Teachers must feel they are important and useful to have put such a priority on obtaining the equipment.

In supporting the issue of this equipment, MEP also produced in-service training packages to go with them. Teachers not only made use of these materials to help them understand the equipment but they also went on courses of two to four days to discuss and work with them. Under the INPUT Pack (11—16 years) training scheme some 12,000 teachers have been trained. For the Microprimer (5–11 years) Scheme, (which has only just started) already some 15,000 teachers have participated in courses. You will notice the wide range of materials in these packages, books, machine guides, audiotapes, overhead transparencies, tape slides and the course computer programmes. The tutors who take the courses that the teachers attend also have carefully prepared kits of materials to use in their own personal way but based on a carefully designed national scheme.

Thus the Programme has been developing approaches, teaching and learning materials, and equipment. The final element in the complete impact on the school is the classroom itself, and we have been working here as well. A computer classroom is not just a place where children learn computer studies and are taught by a teacher dictating knowledge. It is a place where children can come and explore all the many ways in which this equipment can support learning in very many subjects. and thus such a classroom should be completely re-arrangeable, open-ended and exploratory. The design we have established meets all these requirements and provides a pleasant and exciting atmosphere in which to learn.

In a paper of this length, it is not possible to give more than a hint of the philosophies behind the MEP operation. We are obviously producing great quantities of tried and tested materials in a wide range of subjects and media, and in doing so, we have set a large number of wheels in motion for more and more such projects. In what I have discussed, and in the picture I have shown, you have been given a small taster of the operation. I hope you have gained the impression also that all this work, although funded and sponsored from government funds, is firmly based in the curriculum and teachers' needs in meeting the learning requirements of children. There is a carefully plotted and coherent set of plans for the development and production of these materials which fit certain curriculum aims and these are nationally developed. The important issue for the teachers is that they can add to this approach and interpret it in a style which fits the particular group of children with whom they are working.

You will have noticed also that the Programme is comprehensive. We came to the conclusion, early on, that it was not sensible to concentrate on only one aspect, computer studies for example, for the impact of this technology was pervasive throughout the curriculum just as it is throughout society. It was also producing major changes in the way in which subjects could be approached and learnt, and in the attitudes of the children. So you will have seen that we have covered all ages and all subjects. We have also interested ourselves in the teachers, the curriculum, the materials, the equipment and even the classroom. Affecting one without involving another aspect again means that you omit areas that could well prove to be the final constraint in preventing a teacher taking the value of technology into his work.

At the beginning of this paper, I mentioned the word cooperation and I want to return to it now. While the Programme itself is a nationally directed operation, you will have gathered that the work is a joint participation between the teachers, our regional staff, many small working groups and the national directorate. It is not just focussed around the capital, London—indeed the directorate is based in the North of England, in Newcastle—but involves the whole country. Nor are the projects themselves only funded and supported by the education system. We have many joint activities with large and small companies in all parts of our work, another example of cooperation. To distribute and market our products, we have worked with many other commercial concerns, both large and small, publishers, manufacturers and software houses. They are cooperating with us in taking the materials, packaging them in our styles and distributing them all round the world. We too are working with other companies who have developed their own products, and where we think them of value, we are putting them in our information centres and on our courses and discussing how effectively they can be used.

[illegible]

This sense of cooperation has transformed the efforts of the Programme and made it possible to penetrate deeply into the heart of the education system. By involving many different enterprises and people, interest in the work of the Programme, and more especially commitment to its aims and objectives are promoted throughout the country. This is a very useful and successful method of ensuring the propagation of an innovation. The more widespread the network of people the more likely that the effort is diluted and this means more careful control and monitoring, but, at the same time, the more people feel they relate to the work being done and therefore take it into their teaching. We also have to be realistic in our targets. A good supportive approach of cooperation with teachers and educationists does provoke a groundswell of spreading interest, but only those who are willing to allow themselves to be involved will take notice of it. Others will ignore the signs and continue in the same way that they have done for years, and they will not change, just as many other people in society.

The essential point is that we have started the process of change amongst our teaching force, and in our schools. That process will also continue if sufficient of our colleagues also believe that the changes are educationally justified too. We consider that we have passed the critical point, in terms of the provision of equipment, materials, and teacher training. We have produced a great 'thirst' for computer-based-learning in Britain (and possibly other countries too). We must now strive to enable others as well as ourselves, to meet the demands of these teachers and schools.

WORKING PAPERS

Student and Teacher Training Curriculum*

1. Introduction

Now in the early and mid-eighties the impact of the ongoing revolution in microelectronics on the social, economic, educational and scientific systems is almost universally felt and recognised. One of the interesting byproducts of this revolution, in the industrialised world, has been the subtle and marked change in a person's perception of computers and his role vis-a-vis computers. Till the mid-seventies a computer to most people, was some sort of a monster, perhaps benign, under the control of a chosen few, called computer programmers, who possessed unnamed, uncomprehended and esoteric knowledge. Microcomputers have changed all this. The computer is now perceived as a tool whose use does not require any specialised skill and is not limited to advanced scientific computation, automation in industry and maintenance of records.

That such a transformation in one's view of the computer is likely to take place in our country in the near future is not difficult to foresee. There are already many firms marketing imported as well as indigenously assembled microcomputers in the so far unconventional markets in India, viz., home and small business. Once the manufacture of microprocessor and associated chips begins in our country by Semiconductor Complex Ltd., the impact will be much more marked. The pilot project on computer awareness and literacy in secondary schools is one facet of the seed needed to bring about this transformation in perception of computers by people in our country.

2. Student Curriculum

This programme which is aimed at students of 11th and 12th grades in secondary schools, and consists of about 30 lectures/demonstrations

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* This paper was presented by Professor S.N. Maheswari, Department of Computer Science and Engineering, Indian Institute of Technology, New Delhi. The paper does not necessarily represent the views of the sponsoring agencies on the subject.

of one hour each and 30 practice sessions of about two hours each, has as objectives the following :

- To provide students with a broad understanding of computers and their use.
- To provide "hands-on" experience.
- To familiarise the students with the range of the computer applications in all walks of human activity and the computer's potential as a controlling and information processing tool.
- To 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.

Training will be optional in nature and so organised as to enable students of all disciplines to benefit equally.

What should be included in the curriculum depends primarily on two factors, resources available (time, equipment, personnel, etc.), and most important, our understanding of why the microcomputer has had the impact it has had in the industrialised world. Undoubtedly easy availability and low price have played a significant role. But more important than the price has been the tremendous change in programming environments made available to the user. This can be, perhaps, best appreciated by viewing changes in this since computers have been in use in the early 50's The earliest machines were programmed in machine assembly code. The programmer personally controlled various phases of a programme's execution by personally operating the machine. Then came FORTRAN which did away with the necessity of programming in assembly. Multi-user, time sharing operating systems with large resource libraries made the use of machines even more transparent. Availability of text-editors and data-base management systems in the early seventies heralded the coming of environments in which computers could be used by those who did not know or were not expert programmers. Still the user community was small because these packages and computers were expensive and were not easily available. With microcomputers the situation has totally reversed. Sophisticated packages like word processors, data-base systems, and spreadsheets are available at throwaway prices and are extremely convenient and friendly to use. The need to know programming in BASIC or FORTRAN, a task whose degree of difficulty has not significantly decreased since these languages were first introduced, for using a microcomputer in one's day-to-day life, has more-or-less disappeared.

Our curriculum should reflect this trend. It should emphasise problem solving in various areas through the use of generic software packages which involve considerable programming-like activity. Moreover, there is another added advantage of getting into computers through well designed packages. It builds confidence faster and also gives a good idea of potentials and limitations of computers. Also, such problem-oriented programming is easier to teach than "basic programming."

A curriculum based on the above ideas is given in Annexure II in a tabular form with the classroom lecture/demonstration activity juxtaposed with the corresponding laboratory activity.

The first couple of hours are spent by students familiarising themselves with the system, various units and their functions, and developing facility for loading a programme and running it. Word processing makes them a more competent user of the keyboard apart from introducing them to a very important application. Programming in Logo serves the dual purpose of teaching fundamental concepts of programming and introduction to graphics. Use of data-base systems introduces the concepts of information storage and retrieval. Spreadsheet can be considered as an introduction to use of computers in business, accounting and management and elements of simulation. At this stage one can talk to the students about some details of organisation of a machine. Students will be receptive because in all that they have done so far some notions of organisation would already have cropped up informally. Using an appropriate simulation package with proper graphics one can also introduce to the students how a computer functions internally. Remaining time is to be spent in discussing various applications, social issues and in appreciating the use of computers as a formal training device by interacting with various CAI packages

It is quite possible, as past experience tells us, that there would always be some students who would be ready and anxious to do some serious programming towards the end of the programme. They should be encouraged and the instructor should help them to pick up the appropriate language. It is more than likely that it would be BASIC. However programming as an activity should not be included as a compulsory aspect in the programme.

It is likely that the classroom activity will more often be a series of lectures/demonstrations to small groups of students rather than blackboard activity. This should be encouraged as the smaller the group the greater will be the involvement.

It is desirable for the sake of uniformity of implementation that a detailed hour-by-hour curriculum also be drawn out. This can be done once the generic packages to be used for implementing the programme are made available.

3. Teacher Training

It goes without saying that a teacher should know all that the students are to be imparted and more. In view of the wide spectrum of objectives the training of teachers will have to be both intensive and extensive. The teacher should be able to run the computer awareness programme effectively and independently. He should be knowledgeable and be in a position to satisfy the curiosity of students on issues that are likely to crop up in classroom or in laboratory environment. Moreover he should be sufficiently trained on the structure of the system to be able to diagnose simple faults and take corrective action.

The above objectives can be translated into the following functional requirements given in an arbitrary order.

(i) Getting started (2)
(ii) Programming in BASIC (10)
(iii) Programming in Logo (2)
(iv) Ability to put the system together (2)
(v) How does the printer work ? (1)
(vi) BBC Micro architecture and general computer organisation (5)
(vii) Ability to use spreadsheet, word processor, data-base and graphics packages (18)
(viii) History of computing (2)
(ix) Experience with CAI packages to be used in schools (4)

Numbers in parenthesis are the number of hours of classroom activity. Except for the ability to put the system together and the experience with CAI packages, which are essentially practice sessions, the rest will have practice sessions of double the duration. Total classroom activity is therefore of the order of 40 hours and practice sessions are around 80 hours. Total time required is 120 hours. On a six hours a day basis this requires 20 working days, i.e., effectively one month.

What is the order in which the material should be introduced to teachers? It goes without saying that what is good for the students is good for the teachers. The sequence should be similar to that of the students. Programming in BASIC should come towards the end when teachers are expected to be quite mature users of the system.

Teacher Training Curriculum*

Introduction

The recent revolution in microcomputer technology has profoundly affected educational system, business, communication, transport and industry in the countries of Western Europe, the United States of America and Japan. In basic and social sciences problems which could not be studied due to complexity of calculations are being investigated by influencing computer architecture for solving specific problems. Many experiments which are difficult to perform in the laboratory are being studied through computer simulations. It is clear that unless an effort is made to take advantage of this revolution for training the future work force of the country the gap between the advanced countries of the world and the developing countries like India will continue to widen. Microcomputers, because of their low cost, are being marketed as homecomputers and before long they would be as common as pocket calculators. The importance of making our children literate in the language of microcomputers so that they can participate as adults to meet the national aspirations by taking advantage of this revolution cannot be over-emphasised. Therefore, computer education at all levels of the educational system will have to be introduced for preparing our children to compete in the world of work of tomorrow.

As a first step towards meeting this challenge the Department of Electronics (DOE) has proposed to launch in the final year of the Sixth Plan, i.e., 1984-85, a pilot project for computer appreciation-cum-education in secondary schools. The programme is scheduled to commence from July 1984 in about 250 schools throughout the country. The course will comprise about 30 lectures of one-hour duration and 30 practical sessions of two-hour duration in Class XI at the plus two stage of senior secondary school. The objective of the programme is not to expose the underlying principles of computer science and modern electronics but to give confidence to the users that the modern microcomputer can be operated without knowledge of its internal mechanism.

* The paper was prepared by a Working Group in NCERT and was presented by Professor A N. Maheshwari. The paper does not necessarily reflect the views of NCERT or the other sponsoring agencies on the subject.

The next step can be the introduction of different structured courses on computer education both for academic and vocational streams for example, an additional elective course in computer education based on numerical analysis, statistics, computer simulation of scientific concepts and processes can be offered at the plus two stage. Such a course will complement the teaching of these units of the present syllabus of mathematics, statistics and other physical and biological sciences. Another alternative course in computer education can be a vocational course in computer education which could be integrated appropriately with courses in commerce and management. The students with skills of typewriting, accountancy and data processing may find employment with middle level business concerns where microcomputers are likely to be used as a business machine/word processor.

In view of the experience of different countries where microprocessor linked educational curriculum have been evolved and tried, a major finding has been that it is difficult to develop the skill of designing programmes for meeting a specific task. Therefore, care should be taken to avoid direct teaching of programming in structured way in any first exposure to the use of a microcomputer. Programming should be introduced only indirectly through the use of software packages. The students should be trained in the skills such as setting up a microcomputer system and loading in it software either from casette drive or disk drive and to be able to use it effectively consulting the brochures provided with software packages. An important objective of a first course in computer education can be that students should be able to process numbers, words and graphic data using the software packages both for learning the school subjects and for hobby activities.

Student curriculum for the pilot project should be designed keeping in view the points made above. The software packages for a pilot project of this nature should consist of application oriented programmes such as :

1. Word processing
2. Spreadsheet
3. Data-base management
4. Accounting programme
5. Games (Entertainment)

The pilot project will be implemented in the schools by the existing staff of the schools who would undertake the responsibility of computer education in addition to their regular duties. At least three teachers from schools who may not have any prior background or familiarity with the use of microcomputers will have to be trained in short-term training courses specially designed for implementing the project. The teacher training will be carried out in different resource centres; therefore, it is necessary that the teacher training should be done using a common curriculum.

We have presented in this paper a teacher training curriculum for a short-term training course of four weeks' duration for preparing teachers of the participating schools for the pilot project. The design of the curriculum has been structured according to the following scheme :

1. General Objectives

(a) Computer awareness and literacy
(b) Interaction with microcomputers
(c) Programming
(d) Computer arithmetic and logic
(e) Social objectives

2. Syllabus

(a) Introduction to microcomputers
(b) Elements of basic programming
(c) Practical hands-on training

3. Evaluation

The details of each of the components of the teacher training curriculum listed above have been given in the paper under respective sub-headings.

4. Specific Objectives

(*a*) *Computer Awareness and Literacy*

Teachers should be able to :

1. Identify the constituent parts of a microcomputer system.
2. Recognise terminologies specific to microcomputers.
3. Describe in general terms how a computer works.
4. List different high level computer languages.
5. Describe the main components of the Central Processing Units (CPU) of a microcomputer.
6. Identify input/output devices.
7. Identify the hardware parts of a microcomputer system.
8. Recognise the crucial role of software in the working of a computer.
9. Recognise that computers function only through the binary code.

10. Recognise the role of the microprocessor in micro computers.
11. Differentiate between calculators, microcomputer mini computers and main frame computers.
12. Recognise that the usefulness of the computer is limited by the quality of the software.
13 List some common uses of computers.
14. Identify computer related occupations
15. Recognise limitations of computers.
16. Trace the history of computers.

(*b*) *Interaction with Microcomputers*

Teachers should be able to :

1. Identify the input/output devices in a micro computer system.
2. Identify special purpose keys on the keyboard
3. Recognise cursor control operations.
4. Demonstrate skill in editing a programme.
5. Demonstrate the use of the cassette drive and disk drive for saving and loading computer programmes and data.
6. Run a given programme.
7. Demonstrate the use of a prepared programme.
8. Demonstrate the use of various input output devices such as the keyboard, VDU, TV monitor, cassette, disk drive, etc
9. Recognise simple error messages.
10. Demonstrate the use of the microcomputer in word processing.
11. Debug a programme.
12. Demonstrate the use of the microcomputer in drill and practice situations.
13. Demonstrate the use of the microcomputer in a simulation programme
14. Demonstrate the use of the microcomputer for data processing.
15. Demonstrate the use of the microcomputer with an electronic spreadsheet programme.
16. Demonstrate the use of the microcomputer with interactive educational software.
17. Identify some desirable and undesirable consequences of widespread use of computers.

(c) Programming

Teachers should be able to :

1. Identify flow-chart symbols.
2. Read a flow-chart.
3. Discriminate between machine, assembly and higher level languages.
4. Perform simple operations to save, load and copy programmes using a cassette drive or disk drive.
5. Interpret error messages.
6. Use editing procedures to rectify errors in a programme.
7. Design and write a few simple problem-solving programmes using BASIC.
8. Develop strategies for testing and debugging a programme.
9. Translate a given flow-chart into a programme.
10. Modify existing programme as per specific requirements.
11. Predict a computer's output given the listing of a programme.
12. Generate graphic outputs using the graphic capabilities of the microcomputer.
13. Generate simple programmes combining graphics, text and sound.
14. Recognise the machine-specific differences in the BASIC language.
15. List all machine-specific statements (Key words).
16. List all machine-specific commands.
17. Discriminate between statements and commands.
18. Use looping command for literative operations.
19. Use branching commands to direct the flow of a programme.
20. Use subroutines to direct the flow of a programme.
21. Use machine-specific structured BASIC statements to improve the quality of a programme.

(d) Computer Arithmetic and Logic

Teachers should be able to :

1. Recognise computer logic operation.
2. Define an algorithm.
3. Recognise the role of the binary system in computer arithmetic and logic
4. Discriminate between number systems with different bases (binary, octal, decimal and hexadecimal).
5. Convert a number from one system to another.
6. Perform basic arithmetic operations with binary numbers.

7. Discriminate between bit, byte and word length.
8. Recognise Boolean logic operations.

(*e*) *Social Aspects*

Teachers should be able to :

1 Recognise the role of computers in contemporary society.
2. Recognise the role of computers in future society.
3. Illustrate the role of computers in modern science, industry, commerce, communication and transport.
4. Recognise the potential of the computer as a powerful educational tool.

Proposed Syllabi

(To be covered in 30 periods of one-hour duration)

The number of periods recommended for teaching each of the following units has been indicated in parenthesis.

A. Introduction to microcomputers, and computing languages :

1. A Brief History of Computers :

The abacus—Pascal's adding maching—Babbage's difference engine and analytical engine (1822-1933), ENIAC (1946), Computers employing transistor, EDSAC (1949) IC's, microprocessors, LIS's VISI's, etc (1)

2. (a) Microcomputers and their impact on contemporary and future society.
   (b) What is a microcomputer—role of the microprocessor—the 'micro' in relation to the 'mini', and 'main frame' computers.
   (c) Some common applications of microcomputers in education, business and entertainment. (2)

3. Components of a Microcomputer System :

   (a) Microprocessor—CPU
   (b) Interfacing—I/O devices
   (c) External storage devices—cassette drive, disk drive, etc.
   (d) Video display unit, TV Monitor
   (e) Printers—Matrix printer, Letter quality printer
   (f) Keyboard and systems commands. (3)

4. Microcomputer Software :

   (a) Software and hardware—system software and application software.
   (b) Machine language—bits, bytes and word length.

(c) ROM and RAM
(d) Operating systems

5. Programming Languages :

(a) Assembly Language
(b) High Level Languages—BASIC, COBOL, FORTRAN, PASCAL, LOGO, etc.

6. Number and Logic :

(a) Number as—decimal, binary, octal and hexadecimal numbers—binary to decimal conversion—decimal to binary conversion—binary arithmetic operations.
(b) ASCII character codes.
(c) Computer logic and Boolean operations—Logical Operations (NOT, AND, OR, NOR)—truth tables.

7. Storage of Data :

(a) Cassette tape—serial access—disadvantages
(b) Floppy and hard disk—random access—advantages—disk formation—sectors and tracks—chained sectors. (2)

8. Some Common Application Programmes :

(a) Word processing
(b) Mail merge
(c) Spreadsheet
(d) Data-base management
(e) Accounting programmes
(f) Games (Entertainment) (6)

B. Elements of BASIC Programming :

1. (a) Programme—statements—keywords—line-numbers—mode of line numbering—commands (RUN, LIST, BREAK)—REM statements INPUT, PRINT, etc.
(b) Variables and assignment statements—numeric (integer and real) string variables—naming variables.
(c) Mathematical operations
(d) Subscripted variables and arrays (3)

2. Developing a Programme :

(a) Flow charts—conditional and unconditional branching—AND and OR conditions—ON .... GOTO statement—programming economy.
(b) Loops—getting out of loops—FOR ......NEXT statement—nested loops—IF......THEN

(c) Subroutine—calling subroutine—nested subroutine.
(d) Read/Data statements—multiple read and data lines RESTORE and CLR statements—data arrays.
(e) String handling functions—length of a string numeric variables and vice versa—manipulations with the ASCII code—sorting names into alphabetical order.
(f) Random number generation—common applications.
(g) User defined functions.
(h) Graphics—graphic characters—plotting high resolution and low resolution graphics.
(i) Other machine-specific keywords and command such as BEEP. (5)

3. Files and Records :

Components of computer filing system—files, records and fields—techniques of storage and retrieval—operating the filing system. (2)

C. Practical (Hands-on) Training : (To be covered in 30 sessions) The number of sessions each of two-hour duration have been indicated in parenthesis.

1. (a) Identification of various parts of the microcomputer system (keyboard, VDU, cassette/disk drive, printer).
(b) Assembling the parts to produce a fully integrated microcomputer system.
(c) Try-out of the assembled system.
(d) Generating simple programmes and running them.
(e) Debugging programmes.
(f) Saving and loading programmes. (10)

2. (a) Keying in 'ready made' programme listing (including those employing graphics and sound) to accomplish specific tasks. (5)
(b) Debugging and trying out of various educational business entertainment programmes from commercial software cassette/disks.

(i) Word processing
(ii) Data-base management
(iii) Electronic spreadsheet

(b) Interactive try-out.
(c) Evaluation of the programmes from various view points. (10)

4. Try-out of Computer Assisted Instruction (CAI) software package and evaluation of their usefulness in a given situation. (5)

Evaluation

It is extremely important that the short-term teacher training curriculum should have in it evaluation tools for assessing the learning outcomes of the programme to judge if the participating teachers have acquired the necessary knowledge and skills for implementing students' curriculum of the pilot project. The following specific learning outcomes may constitute the minimum needed for the purpose.

1. Identify the input/output devices in a microcomputer system.
2. Identify special purpose keys on the keyboard.
3. Recognise cursor control operations.
4. Demonstrate the use of the cassette drive and disk drive for saving and loading computer programme and data.
5. Run a given programme.
6. Demonstrate the use of a prepared programme.
7. Demonstrate the use of various input/output drive, etc.
8. Recognise simple error message.
9. Demonstrate the use of the microcomputer in word processing.
10. Demonstrate the use of the microcomputer in drill and practice situations.
11. Demonstrate the use of the microcomputer in a simulation programme.
12. Demonstrate the use of the microcumputer for data processing.
13. Demonstrate the use of the microcomputer with an electronic spreadsheet programme.
14. Demonstrate the use of the microcomputer with interactive educational software.

Focus on Computer Education

The National Council of Educational Research and Training (NCERT) envisages introduction of different structured courses in computer education in schools both for academic and vocational streams in a phased manner.

The NCERT is planning to introduce a phased programme of incorporating computer education component in its 4-year B.Sc-Ed. teacher training course offered by the four Regional Colleges of Education (RCEs) located at Mysore, Bhubaneswar, Bhopal and Ajmer. At the RCE, Mysore, work in this direction has been going on for the past one year using both imported and indigenous microcomputers. In the structure of these 4-year courses it is proposed to introduce appropriate courses on computer education and its teaching methodology in the third and fourth years of the courses. In addition to the pre-service teacher training, the RCEs shall offer short-term in-service courses in computer education and conduct extension programmes on computer awareness and literacy for teacher educators and educational administrators.

The Vocationalization of Education Department of the NCERT has started a phased programme for the development of course curriculum for the introduction of vocational course in computer education to be offered in senior secondary schools. A workshop for development of "minimum vocational competency-based curriculum on computer techniques" was recently organised by the same Department. A draft curriculum for the introduction of a course on computer techniques for vocational stream was prepared in this workshop.

In addition to these two recent activities of the NCERT for the introduction of computer education in schools the Council has been involved in training participants of Asian countries in the area of programming using its Large Scale Integrater (LSI-II) main frame computer. The NCERT has been processing data of research project in education including the processing of National Talent Search Examinations. A Working Group in the NCERT has been constituted for coordinating the tasks relating to design of curriculum for computer education courses at the various levels of the school education, preparation of instructional material, teachers' guides, pre-service and in-service teacher training and development of CAI software packages.

Computer Education for the Young*

1. Microelectronics, which has made cheap microcomputers possible, is transforming the economy of industrialised nations the world over and increasingly affecting the jobs and lives of many people. Computing power is the only commodity which is falling in cost each year, and personal microcomputers will soon find their way in innumerable homes much on the pattern of calculators and digital watches which were virtually unknown a decade ago. However, unlike them, computers offer a growing number of people a practical and versatile new tool for controlling a variety of processes and juggling with information. Microcomputers are in effect bringing about the same kind of revolution in the society as was witnessed when engineering got into business during the Industrial Revolution.

2. Just as at that stage engineering literacy was relatively rare and made the difference between the abilities of the nations to benefit from the Industrial Revolution, today we are at a point where computer literacy has the same potential and urgency for the development of our country.

3. It is estimated that the world market in information technologies in the year 1990 would be of the order of Rs. 600 crores a day (Rs. 2,20,000 crores per annum). The ability of any country to carve out a share of this market will depend critically on the availability of people trained in necessary skills. Even if India's potential share of this world market is estimated to be no more than a few percent, the enormity of this market and, therefore, the need to prepare suitable manpower is self-evident. Education is about the future and the nation's future prosperity depends on the quality today of the education of those who would be tomorrow's work force. Children who are today in primary and secondary schools will be the bearers of this computer based industrial and social revolution in the country—from which no individual household, industry, business or occupation will have been left untouched. Patterns of employment will have changed and today's children will need to be trained for jobs which such technological advances will generate.

* The paper was prepared and circulated by the Manpower Division of the Department of Electronics, Government of India. The outline of pilot project as suggested in this paper has undergone change subsequently.

4. If these opportunities are to be accepted, an essential part of children's spectrum of educational skills will be familiarity with the use and application of computers.

5. With this in mind, DOE plans to introduce computer education in schools and colleges in a phased manner with the following objectives

—To provide students with a broad understanding of computers and their use.

—To provide hands-on experience.

—To familiarise 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.

—To demystify computers and to 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.

The emphasis in this programme will be on manipulative skills rather than on teaching principles of computer science.

6. It is proposed to introduce this programme from top down, i.e., the programme would first be introduced at the secondary higher secondary schools and colleges, and would then be extended to middle and primary schools. (It may be mentioned here that the Computer Education Programmes have been/are being initiated at territory/degree levels). This way the students of primary schools would be able to get training in more relevant skills as they advance through their educational careers. Another reason to start the programme first at the secondary school level is that the student output will go into the nation's work force much sooner than the children in primary schools and, therefore, should be given priority. Besides, as the dimension of the problem at the secondary stage is some what smaller, it would be more manageable in the beginning and with the experience gained at this stage, it would be possible to implement computer education programme on a wider scale at the primary level subsequently.

7. The basic elements of the scheme are as under :

—Computer education should be introduced at secondary and higher secondary levels at the outset, to be followed by computer literacy programme at middle and primary school levels.

—Computer education would be part of curriculum of every student irrespective of eventual branching into science, humanities, commerce, etc.

—The computer literacy programme would enable students to become familiar with the computer and its potential as a versatile tool with applications in all aspects of human endeavour.

8. **Pilot Project** : Our country has about 5,500 colleges, 55,000 secondary and higher secondary schools, and about 620,000 middle and primary schools. Obviously, it would not be easy to launch the programme at all these centres simultaneously. It is, therefore, proposed that, in the final year of the Sixth Plan, i.e., 1984—85, a pilot project is launched, located on a limited number of institutions which should be so chosen as to be similar in character in terms of language of instruction, course curriculum and administration. One possibility would be central schools which meet this criterion and would, therefore, provide a suitable structure for the initial effort. This would also enable identification and resolution of problems relating to long chains of communications, physical distances, regional differences, etc. This experience could be highly useful at the stage of the subsequent wider implementation of the scheme. Alternatively, we could think in terms of selecting a physically limited target area and cover all secondary schools in that area. Example could be the Union Territory of Delhi. This would have an advantage in terms of reducing administrative problems which arise from implementing a project over diverse locations.

Either of these two could be adopted for the start ; a decision would have to be taken about this at the outset as the infrastructure for implementation of the scheme would be significantly different in the two cases. Our present proposal is based on the first alternative which is to initiate the computer education programme at about 450 Central Schools located at different locations throughout the country.

9. It is proposed that computer education will be a full subject as a regular part of students' curriculum. The programme would consist of about 30 lectures each of one-hour duration and 30 practical sessions each of two-hours duration. Detailed issues of implementation would have to be discussed with the concerned agencies such as the Ministry of Education, NCERT, Central Board of Secondary Education, etc.

It may be mentioned that a computer education programme with similar objectives has been recently implemented successfully in the United Kingdom. It is intended to take full advantage of the British experience in mounting the pilot project. In order to speed up the process of implementation and to avoid 're-inventing the wheel' it is proposed that the hardware and software for the programme should be the same as in the case of the British programme. Clearly, new software would have to be developed ultimately to suit particular requirements and conditions of our country, but for the start, full use could be made of the excellent range of educational software developed as part of the British programme.

The scheme is proposed to be implemented in collaboration with the Ministry of Education and Culture. An implementation committee covering DOE, Ministry of Education and Culture, SCL, CMC, Central Schools Organisation, etc., would be set up; the exact composition would be finalised at an appropriate stage. The committee would draw up a detailed plan of the pilot project including implementation schedule, financial requirements, administrative structure and so on. With a view to fully understanding the British programme and benefitting from its experience it would be necessary to send a sub-group of the implementation committee to the United Kingdom. The group is expected to study and discuss threadbare all components of the British project. The report of this group would form the basis for finalising our own programme.

The main components of the pilot project are as follows :

(A) Defining detailed educational objectives.

(B) Designing curriculum with the above in view.

(C) Preparation of course materials and texts.

(D) Selection of teachers from target schools. Teachers would be required on full-time basis. They may be required to execute a bond not to opt out of the scheme for at least three years in order that the implementation is not jeopardised.

(E) Teachers' training programme :

- (i) Designing training course for the teachers.
- (ii) Preparation of course material and teachers' guides.
- (iii) Evolving an administrative and training structure for rapidly generating the required number of trained teachers.
- (iv) Identifying and recruiting resource persons for teachers' training programme.
- (v) Identifying sources for generating educational and computer application software.
- (vi) Setting up maintenance arrangements for computer hardware and software.
- (vii) Selecting an appropriate mode of examination.
- (viii) Setting up an effective monitoring mechanism.
- (ix) Setting up resource centres for providing advice/consultancy to teachers and schools.

10. **Extension of the Pilot Project :** As soon as the initial pilot project mentioned above is successfully launched the following extensions of the project will be taken up :

(A) *Computer literacy programme at the middle and primary levels* : Since most of the central schools have classes starting from First onwards, it should be possible to introduce the computer literacy programme at the middle and primary levels. This programme will require only limited augmentation of the hardware installed for the pilot project. However, the course material and the software would have to be different. At this level the software is more important because of much greater emphasis on using the computer as a black box with a variety of real-life applications—the software therefore would have to be selected very carefully. This programme can begin soon after the start of the main programme, as soon as teachers are trained for the literacy programme, using the teachers already trained under the 'computer education programme' for the higher secondary level.

(B) *Computer Aided Instruction (CAI)* : After establishing computer literacy/computer education programmes in schools, it is intended to exploit fully the educational value of the computer. At this stage computers will be used to improve the teaching of other subjects such as physics, mathematics, biology, environment, etc. The computer would be used to provide information, motivate learning through the use of animation and graphics, and to convey complex concepts by the process of simulation. The intention is not to replace/displace the teachers but to enhance the ability of the teachers to educate more effectively. This activity may be dependent on the availability of proper CAI software. Programmes will have to be launched for the preparation of CAI software at the very first stage of the pilot project.

(C) *Use of Hindi and regional languages* : Use of Hindi and regional languages in addition to English, for important instructions in the computer literacy programme will be progressively attempted.

11. **Universalisation of Computer Literacy/Computer Education** : After having sorted out the teething problems through the pilot experiment described earlier, it is proposed that computer literacy/computer education programmes should be implemented throughout the country in the Seventh Plan. At this stage, an additional aim would be the indigenisation of the programme to the fullest extent possible To prepare for launching of the country-wide programme, the following advance action would be necessary :

—Indigenous manufacture of the computer systems.

—Training of teachers in required numbers.

—Use of Hindi and other Indian languages in computer education.

12. **Computer System Requirement for the Pilot Project** : Keeping the broad ultimate objectives and the objectives of the pilot project in view, the following specification is proposed for the pilot project stage :

Computer Hardware : 8-bit Microprocessor, 32K RAM, 32K ROM, high resolution graphics, 12″ monochrome colour moni-

	tor, 5 1/4" floppy drive, 80 column dot-matrix printer.
Computer Software	: Operating system, BASIC interpreter, educational software, application packages and optional features such as local networking, Teletext, Speech Synthesis.
Education Aids	: Video Cassette Player (VCP).

The above represents the current best estimate of the system configuration which will be suitable. However, exact specifications can only be finalised once full details of various elements of the project have been worked out. In terms of hardware, to mention some options, it is possible to replace the 12" monochrome monitor with a TV monitor or with a 12" colour monitor. Each option has its advantages and disadvantages in terms of the total educational value. Similarly, the floppy drive could be replaced with a cassette recorder depending on the exact requirements. It is also felt that a video cassette player will be a valuable addition to the facilities because of the ability to replay course material which may be supplied on video tapes from a variety of sources now available.

13. **Maintenance and Service Support:** As the computer systems would be located at different places all over the country, it may not be cost effective for these systems to be maintained in the normal way at computer locations. It would be economical if a few central locations are selected in each region where certain number of additional systems would be available ; educational institutions would be able to exchange their effective systems with the good one at these centres. Defective systems would be collected at a few locations and serviced by the Computer Maintenance Corporation or any other agency identified for the purpose. The advantage of 'maintenance through replacement' would be minimisation of interruptions in the education programme and optimal utilisation of maintenance manpower which is generally in short supply.

14. **Teachers' Training** : The most crucial element of the programme is the generation of an adequate number of trained teachers for running the education programme. The duration of the teachers' training programme is proposed to be three months initially. This duration has been proposed assuming that teachers would be having practically no previous exposure to computers. These teachers would have to be supported extensively by resource persons and by making available detailed teachers' guides and other teaching material. Some resource centres will be set up to provide opportunities for close interaction with resource persons and to make use of any teachers' training material which might be set up there.

ANNEXURES

ANNEXURE I

List of Resource Centres

Andhra Pradesh

1. Regional Engineering College,
   Warangal-506004
2. University Computer Centre,
   Osmania University,
   Hyderabad-500007

Assam

3. Assam Engineering College,
   Juluk Baui, Gauhati-781013
4. Regional Engineering College,
   Silchar-788010

Bihar

5. Birla Institute of Technology,
   (BIT), Mesra, Ranchi
6. Muzaffarpur Institute of Technology,
   Muzaffarpur-842003

Gujarat

7. L.D. College of Engineering,
   Navrangpura,
   Ahmedabad-380015
8. Faculty of Tech. & Engg.
   M.S. University of Baroda,
   Baroda-390002

Haryana

9. Kurukshetra University,
   Kurukshetra-132119

Jammu & Kashmir

10. Regional Engineering College,
Naseembagh,
Srinagar-190006

Karnataka

11. Regional College of Education,
(NCERT), Mysore-570006
12. Indian Institute of Science,
I.I.Sc., Bangalore-560012

Kerala

13. College of Engineering,
Engineering College P.O.,
Trivandrum-695016
14. University of Cochin,
Cochin-682301

Madhya Pradesh

15. Government Engineering College,
Jabalpur-482001
16. Technical Teachers Training Institute (TTTI),
Shyamla Hills,
Bhopal-462002

Maharashtra

17. Walchand College of Engineering,
Vishram Bagh,
Sangli-416415
18. Computer Science & Engg. Deptt.,
Indian Institute of Technology,
Powai, Bombay-400005
19. Tata Institute of Fundamental
Research (T.I.F.R.),
Colaba, Bombay-400005
20. University of Poona,
Pune-411007

Orissa

21. Regional Engineering College,
Rourkela-769008

22. Utkal University,
Vani Vihar, Bhubaneswar-751004

Punjab/Chandigarh

23. Thapar Institute of Engineering and Technology,
Patiala-147001
24. Technical Teachers Training Institute, (TTTI), Sector-26
Chandigarh-160026
25. Punjab University,
Chandigarh

Rajasthan

26. Malviya Regional Engineering, College (MREC),
Jaipur-302084
27. Birla Institute of Technology and Science (BITS),
Pilani-333031

Tamil Nadu

28 Indian Institute of Technology,
Madras-600036
29. P.S.G. College of Technology,
Peelamedu Post,
Coimbatore-641004

Tripura

30. Tripura Engineering College,
Barjala, Tripura-790055

Uttar Pradesh

31. Aligarh Muslim University,
Aligarh-202001
32. Indian Institute of Technology,
IIT, Post Office,
Kanpur-208016
33. Motilal Nehru Regional Engineering College,
Allahabad-211004

34. University of Roorkee,
Roorkee-247672
35. Banaras Hindu University,
Varanasi

West Bengal

36. Bengal Engineering College,
Botanic Gardens, Shibpore,
Howrah-711103
37. Indian Institute of Technology,
Kharagpur-721302
38. Jadavpur University,
Calcutta-700032

Delhi

39. Department of Computer Science,
Delhi University,
Delhi-110007
40. Indian Institute of Technology,
Hauz Khas,
New Delhi-110016
41. National Council of Educational
Research & Training (NCERT),
Sri Aurobindo Marg,
New Delhi-110016

Goa, Daman & Diu

42. College of Engineering,
P.O, Pormagudi,
Goa-403405

ANNEXURE II

Curriculum Recommended by the Workshop for Orientation of Resource Centre Personnel

Lecture	*Time Days*	*Practice Session*	*Time Days*
1	2	3	4
Orientation :			
— Programme Perspective — Curriculum discussions — Teacher — Student	¼	— Training Power-ON/OFF — Loading & running some standard programme	½
— System Description — Hands-on Experience with the system	¼		
Curriculum :			
— Overview — Getting started — Word processing	¼	— Learning to use a word processor — Prepare a letter and a report as an example	½
— LOGO/graphics	¼	— Learn how to create and manipulate simple graphical objects.	3/4
— Data-base/spreadsheet		— Prepare a data-base for	1

1	2	3	4
Explain elementary concepts in and usage of data-bases and spread-sheet	½	Use of spreadsheet in solving a simple business problem.	
— Computer organisation	¼	— Go through a CAI package that demonstrates the basic operation of a computer	¼
— Social implications of computers	½		
— Putting of system together and maintenance	¼	— Actually go through the exercise of putting the system together	¼

ANNEXURE IIA

Programme Recommended by the Workshop for the Training of Teachers*

Lecture	Time Hrs.	Practice Sessions	Time Hrs.
1	2	3	4
Orientation			
— Objective of the programme — Role of teachers — Tools to work with	2	—	—
Getting Started			
— Identify parts of the classroom computer (monitor, keyboard, diskette, etc.). Explain their functions and usage.	3	Turn the system ON/OFF Load run some interactive programmes.	4
Curriculum			
— Outline the student curriculum	2	—	—
Word Processing			
— Creating, editing, formulating and printing documents. Familiarity with concepts of inserting; deleting and formulating text.	6	1. Create and print a letter 2. Create and print a small report 3. Prepare and print a table.	12

* The programme finally implemented under the Project in June-July 1984 puts greater emphasis on the educational aspects of computing.

1	2	3	4
LOGO/Graphics			
— Basic commands, defining and manipulating objects, sequencing of operations, building complex graphics patterns from simpler forms.	4	3. Exercise of increasing sophistication to develop skills in man-machine interaction.	22
Data-base/Spreadsheet :			
Explain in very simple terms the concept and use of data-base, queries, report generation, demonstrate use of spreadsheet in planning and simulation.	8	1. Create a simple data-base for school library. Design and use que query's for their data-base. 2. Develop & use spread-sheet for a business problem.	16
Basic Programming :			
Introduce simple elements of BASIC	5	Write 2 or 3 simple programme in BASIC	10
Computer Organisation :			
Identify and explain elementary parts of a computer system. Retake these to the classroom system.	4	Go through a package that simulates certain aspects of computer operation.	8
History of the Computer			
CAI packages to be used in schools.	1	Run some of the CAI packages.	4
Maintenance :			
Putting the system to other — Basic trouble-shooting — Interfacing with maintenance organisation.	2	Go through the exercise of bringing a system up from a disconnected state. Execute simple diagnostic programmes.	4 10

1	2	3	4
Monitoring & Education :		*Project*	
— Evaluation Plan — What is to be mentioned — Interfacing with resource centres.		— Examples : — Developing a small data-base for a problem drawn from classroom/personal context — Some problem solving in physics, maths, finance, etc., using spreadsheet. — Time-tabling for the school	10
	40		80

ANNEXURE IIB

Curriculum Recommended by the Workshop for the Computer Literacy Course for Students*

Lectures/Demonstrations		*Practice Session*	
1		2	
1 Hour :	Getting started. Explain how to use system keyboard disk, cassettes, etc.	2 Hours :	Load some game programme and play.
4 Hours :	Word processing, test entry, i.e., creating document, editing, deleting, inserting, formatting, printer control, etc.	6 Hours :	Two to three exercises of representative nature
4 Hours :	Logo (graphics), basic commands, notion of a defined object, sequencing and creating a complex graphics pattern.	8 to 12 Hours :	Three to four exercises of various levels, involving skills development.
8 Hours	Data-base and spreadsheet, searching, sorting, report generation based on simple statistical processing. Use of spreadsheet in planning and simulation. Examples from business, electrical circuits, etc.	16 to 20 Hours :	One to two project type exercises conducted in groups.

* The curriculum finally recommended for the Pilot Schools is a modified version of the present one.

1	2
3 Hours : General organisation of a computer. Bit, byte, RAM, ROM, I/O, etc. How does a machine operate ?	6 Hours : Various exercises using a package which simulates the organisation of a computer.
2 Hours : Use of computer in a programmable calculations mode. Simple formula calculation and table creation, etc.	6 Hours : 2 to 3 exercises of various degrees of difficulty.
2 Hours : Social implication and future developments and applications in our country.	4 Hours : Use CAI packages in chemistry/physics/mathematics/social sciences, etc.

ANNEXURE-III

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ANNEXURE IV

Programme Schedule

1st Day—26 March 1984

9.30 AM to 10.00 AM	Inauguration
10 AM to 10.30 AM	Tea break
10.30 AM to 10.00 PM	Introductory talk and discussion
1.00 PM to 2 PM	Lunch break
2 PM to 3 PM	Presentation by U.K. experts
3 PM to 4.30 PM	Demonstration BBC (Microcomputer)

2nd day—27 March 1984

9.30 AM to 10.30 AM	Meeting of resource centre coordinators
10.30 to 11 AM	Tea break
11 AM to 1 PM	Discussion on Curriculum
1 PM to 2 PM	Lunch break
2 PM to 4 PM	Discussion on management, monitoring and evaluation of the project.
4 PM to 5.30 PM	Concluding session Recommendations
5.30 PM to 6.30 PM	Valediction