DOCUMENT RESUME

ED 315 040 IR 014 147

AUTHOR	Vickers, Margaret
TITLE	Microcomputers & Secondary Teaching: Implications for Teacher Education. Report on an International Seminar Arranged by the Scottish Education Department in Cooperation with the Organisation for Economic Cooperation and Development (Glasgow, Scotland, October 12-15, 1987).
INSTITUTION	Scottish Education Dept., Edinburgh.
SPONS AGENCY	Organisation for Economic Cooperation and Development, Paris (France).
REPORT NO	ISBN-0-86011-133-4
PUB DATE	Jul 88
NOTE	41p.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Reports - Research/Technical (143)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Classroom Techniques; Cognitive Processes; *Computer Assisted Instruction; Curriculum Development; Foreign Countries; Inservice Teacher Education; *Learning Strategies; *Microcomputers; Preservice Teacher Education; Secondary Education; Surveys; *Teacher Education; *Use Studies

ABSTRACT

This seminar, attended by experts and officials from 18 of the Organisation for Economic Cooperation and Development's (OECD's) 24 member countries, focused on the pedagogical implications of the use of microcomputers for subject teaching in secondary schools. Although the main objective was to examine the teacher education implications of microcomputer use, it was necessary to put this in context, and a survey of patterns of microcomputer use in OECD member countries was conducted in preparation for the seminar The results of this survey are discussed in the first of three major sections of the report and lectures, video presentations, and software displays were used during the first 2 days of the meeting to show how microcomputer applications are being used in classroom settings. The second section provides an overview of group discussions on the changes in curriculum, learning processes, and classroom management associated with microcomputer use in the various member countries. The final section considers the areas of agreement that emerged concerning the teacher education implications of microcomputer use. The report also includes lists of papers and materials distributed or demonstrated during the seminar and a directory of seminar participants. (28 references) (GL)

IMPLICATIONS FOR TEACHER EDUCATION

Report on an International Seminar arranged by the Scottish Education Department in cooperation with the Organisation for Economic Cooperation and Development

Glasgow, Scotland 12-15 October 1987

FOREWORD

In October 1987, experts and officials from 18 of the OECD's 24 Member countries gathered in Glasgow for a 4-day International Seminar on "Microcomputers and Secondary Teaching - Implications for Teacher Education". The Seminar, which was officially opened by Mr Michael Forsyth, MP, Minister for Education at the Scottish Office, was organised by the Scottish Education Department in co-operation with the Centre for Educational Research and Innovation of the Organisation for Economic Co-operation and Development (OECD/CERI).

The Seminar focused on the pedagogical implications of the use of microcomputers for subject teaching in secondary schools. Whilst computer awareness courses may be important at the introductory stage, the educational benefits of using microcomputers will only become evident through the identification of practices which demonstrate how they can help schools to achieve their central curriculum objectives. In addition it is essential to examine the extent to which these technologies lead to new ways of knowing, and to incorporate this understanding into the curriculum.

The major formal contributions to the Seminar included the OECD Secretariat overview paper, a commissioned report from the Netherlands, and the Scottish Inspectorate report, which was presented during the Ministerial opening.

It was appropriate that the venue for the Seminar was the premises of the Scottish Council for Educational Technology (SCET), since the Council is at the forefront of the work in microelectronics in Scottish education and in the practical application of new technologies to learning and teaching in schools and colleges.

Owing to the exceptional facilities of SCET it was possible to make use of a wide range of sample software and to present videotaped examples of actual classroom implementation, provided by several Member countries. The report presented here reflects the rich background of information made available through conference discussion, commissioned papers and national reports supplied by Member countries.

It was particularly gratifying that so many delegates were able to attend, and benefit from the exchange of ideas that occurred.

The work of those who were involved in arranging the Seminar is gratefully acknowledged; thanks are also due to SCET for providing the facilities, and to OECD/CERI, for its professional and organisation input.

Scottish Education Department
June 1988

TABLE OF CONTENTS

INTRODUCTION

1. When microcomputers were first introduced into secondary schools in the early 1980's, little had been done to develop software or teaching strategies to support their use in most subject areas. Applications in areas such as mathematics and business studies were obvious, but at the secondary level the development of computer awareness courses was the most conspicuous feature of this period.

2. By the late 1980's the situation had changed significantly. A wide range of subject specific software is now available for language teaching, social sciences, the humanities, music and graphic arts. Curriculum materials and methods for using tool packages, such as word processors and databases, have also been developed. The value of these applications for the teaching of basic skills and concepts was discussed at an OECD International Seminar in Paris in October 1986. During 1986 and 1987 HM Inspectors of Schools in Scotland surveyed computer applications in Scottish secondary schools, with the objective of identifying examples of good practice that should be disseminated on a national basis through teacher development programmes (SED, 1987).

3. With the publication of the Scottish Education Department report (which was launched at the Seminar), and the OECD report on Information Technologies and Basic Learning (OECD-CERI, 1987) both Organisations were convinced of the need for an international seminar which would go beyond the identification of effective subject applications, and would focus on desirable changes in the skills, work roles and classroom organisation that teachers should be encouraged to adopt as they begin to use microcomputers in their classrooms.

4. The Seminar very clearly emphasised the idea that microcomputers could act as a catalyst to educational reform. Educational leaders in Scotland, and in several other Member countries, are using the unsettlement associated with this innovation to ask teachers to once more pursue sound practices which have long been valued but have so often proved elusive. Evidence is emerging which suggests that microcomputers can make exploratory learning more feasible, they can be used to structure group work, and in addition, new forms of teaching and learning are becoming possible.

5. Although the main objective of the Seminar was to examine the teacher education implications of microcomputer use, it was necessary to put this in context. A survey of patterns of microcomputer use in OECD Member countries was conducted in preparation for the Seminar; the results of this survey are discussed in the first section of the report. During the first two days of the Seminar, lectures, video presentations and software displays were used to show how microcomputer applications are being used in classroom settings. Group discussions examined the changes in curriculum, learning processes and classroom management associated with microcomputer use in the various Member countries. The second section of the report provides an overview of these. The final part deals with those areas of agreement that emerged concerning the teacher education implications of microcomputer use.

SECTION I

PATTERNS OF MICROCOMPUTER USE IN SECONDARY SCHOOLS IN OECD MEMBER COUNTRIES

6. Data on computer applications in OECD Member countries collected in preparation for this Seminar give some indication of the scale of the enterprise (see summary in Table 1). Seven Member countries now claim that between 98 and 100 per cent of their secondary schools are "equipped", even if supply varies significantly both within and between these countries. Scottish secondary schools have 20 microcomputers on average, and the averages for Australia, Denmark, France, England and Wales, Iceland and the United States, lie between 9 and 18 per school. In addition to these seven countries, the Netherlands reported in 1987 that 90 per cent of secondary schools had between 8 and 10 computers depending on the type of school and that under the NIVO programme each school will receive 11 more microcomputers (Nagtegaal and Scholtes 1987). In Austria it is reported that all upper secondary schools have at least 10 microcomputers. It is likely that the supply of equipment in most Member countries will continue to increase, especially in those countries where current stocks are relatively small. Portugal, Spain and Japan have announced programmes that will significantly increase their computer education activities before the end of this decade.

7. Before outlining patterns of microcomputer use in Member countries, some necessarily arbitrary decisions about terminology will be imposed. The term "computer awareness" will be used to refer to those courses of study mostly presented at lower secondary level, variously called informatics, computer literacy, computer-studies, information science and so on, which deal with advanced technologies and their role in modern society, and which emphasise computers as a new component of our culture. These are distinguished from subjects which are primarily concerned with teaching programming and computer applications, which will be called "computer science".

8. In those Member countries where there are significant quantities of hardware in place, two trends emerge. There are more microcomputers in secondary schools than in primary schools, and the patterns of use at the two levels are markedly different. In those countries for which we have data, it appears that microcomputers are mostly used at the primary level for teaching traditional subjects and basic skills. But in the secondary schools, in the majority of Member countries, the most conspicuous change brought about by the microcomputers was the creation of new subjects such as computer awareness at junior levels, and computer science at senior secondary levels and in the vocational schools.

Table 1

AVAILABILITY OF MICROCOMPUTERS IN SECONDARY SCHOOLS IN SELECTED OECD MEMBER COUNTRIES

Country and School Type		% of Schools with Microcomputers	Average no. of micros. in schools that are equipped
AUSTRIA (Upper Secondary)		100	10
AUSTRALIA		98-100	14
DENMARK			
	Lower secondary, public	93	] 10
	Lower secondary, private	64	]
	Upper secondary	100	12.9
FRANCE	(College)	100	9
	(Lycée)	100	17
FRG	Hauptschulen	45-50	5
	Realschulen	75-80	5-8
	Gymnasien	100	7-12
	Vocational schools	75-80	10-12
ICELAND (Upper Secondary)		100	12
IRELAND		90-95	5-6

JAPAN - 15% of lower secondary and 83% of upper secondary "preparing to use" microcomputers. About 1.5% of upper secondary have more than 20. In 1983 upper secondary schools with computers averaged 4.2 computers per school.

NETHERLANDS			
	(Lower vocational school)	100	7 (+11)
	(General secondary school)	100	9 (+11)
NORWAY	(Upper secondary)	90	8-12
PORTUGAL		23	4
SWEDEN	(Lower secondary)	Most schools had at least 1 computer	50% average more than 4
U.K.	(England & Wales)	100	13.4
	(Scotland)	100	20
U.S.A.	(Small School)	100	12
	(Medium School)	100	16
	(Large School)	100	19

Reference: OECD-CERI Secretariat report 1987, Microcomputers and Secondary Teaching: Implications for Teacher Education (Annex 1) Restricted.

9. This pattern does not apply in all cases. In some countries, integrated use across the curriculum is declared as policy, and computer awareness is not taught as a separate subject; in others computer awareness is compulsory; and in the third and largest group, computer awareness may be commonly taught, but towards the integrated use of microcomputers in all subject areas. This may ultimately remove the need for computer awareness courses.
Source: OECD Questionnaire, 1987

Policies Supporting Integration

10. France, Norway and Portugal fall into the first category. Computer use is specifically integrated into the curriculum at the lower secondary level. In France, various forms of computer science are also available as optional studies for senior students.

11. Given both the scale of the operation, and the clarity of its policies, France represents a special case. Under the plan "Informatique pour Tous" each College (lower secondary school) was provided with at least one professional and six domestic-type microcomputers. Each Lycée (upper secondary school) has a network of one professional and eight domestic-type microcomputers, plus three independent professional computers. In 1985 and 1986, schools were granted a quantity of software certified by the Ministry of Education and available through a nationally distributed catalogue. Under the National Plan, over 157,000 teachers had received a 50-hour initiation course in computing by the end of 1985.

12. However, a report of l'Inspection Générale, Ministère de l'Education Nationale (France, June 1985) found that despite increases in equipment provision, actual microcomputer use in classrooms remained steady or even declined; equipment was under-used and teachers were disaffected. Although lack of quality software was cited as a partial cause, the main reasons given for teachers not using the microcomputers related to pedagogical organisation and teacher training. One quarter of the teaching force had been trained on how to use the machines themselves, but it is now believed that these courses lacked an adequate pedagogical base, and did not provide the necessary experience in actually applying computers in classroom settings.

13. The French Inspectorate report also found that teachers were reluctant to use the equipment because the number of workstations was inadequate for whole class teaching, leading to problems of organisation. Training in pedagogical techniques which involve allowing different groups of students to engage in different activities, and an acceptance of some degree of individualisation of learning, seem to be necessary components of the assimilation of microcomputers into the classroom. It is clear that in countries with a pedagogical tradition based on whole class teaching for an examination oriented syllabus, the introduction of microcomputers will pose particular challenges.

Computer Awareness for All

14. A second grouping of school systems appears to have taken an equally decisive stand in the opposite direction; that computer awareness will be compulsory for all students at the junior secondary level, and that computer laboratories will be equipped and teachers trained to this end. This approach seems to have been widely adopted in Austria and the

Federal Republic of Germany, but the Canton of Genève provides by far the clearest available example of this policy.

15. The Geneva case illustrates clearly both the rationale and the consequences of assigning separate subject status to school computers. A recent study, Scolarisation de l'informatique à Genève (Felder, 1987) illustrates how, when microcomputers first came on to the market, certain enthusiasts who perceived opportunities for improving the teaching of their subjects started experiments in their own classrooms. It was however, believed that if these enthusiasts had their way, computers would become the property of those particular departments, usually mathematics and science departments. Against this, it was argued that computer awareness is a new form of literacy; that it is essential to the new culture of the modern human being. In the interests of equity, the new information and processing machines should not be taken over by the élite and "masculine" disciplines of mathematics and science.

16. In academic circles at this time a new body of specialists - the information scientists - were establishing their legitimacy. Their tools and techniques were applicable to a wide range of disciplines. In the course of creating their own power base, they supported moves in the secondary education sector which led to the emergence of a new cadre of teachers whose professional credentials are defined in terms of this new discipline.

17. Thus, informatics became a compulsory subject in Geneva. Rigorous training was instituted as a prerequisite for the teaching of computer awareness; a well-defined three year syllabus for the "Cycle d'Orientation" was put in place, and the enthusiasts who had experimented with the integration of microcomputers into subject teaching found themselves on the outside. The institutionalisation of computer awareness has meant that teachers who are not trained as specialists in this subject find it difficult to gain access to the tools.

18. The official policy in these countries is to make computer awareness compulsory, without excluding applications in other subject areas; but in general the quantity of equipment that would be required is not sufficient to allow for this. Students are therefore often taught a body of information management techniques and theories which are divorced from their most legitimate purpose, that is, the understanding of the traditional subjects themselves.

The Laissez-faire Approach

19. In the third and largest group of countries, a laissez-faire approach was adopted. Hardware found its way into the schools ahead of the curriculum development and teacher education that would be required to make it effective. Although the equipment was theoretically available to all, in practice it was monopolised by those teachers who already knew how to use computers - predominantly mathematics teachers together with some business studies teachers and self-taught computer enthusiasts. The most bureaucratically convenient arrangement has emerged as the dominant one; typically all of the computers are locked in one room where they can be used by senior science students for mathematics and computer studies, and by junior students for computer awareness. In this way the innovative potential of the microcomputer has been decisively contained - its influence on the teaching of mainstream subjects has been minimised.

20. A study published by the U.S.A. Center for Social Organisation of Schools (1983) found that in schools using computers for instruction, the vast majority of the activity consisted of teaching students about computers or teaching them programming (mostly BASIC) and that in terms of time spent per week, the typical student who uses a microcomputer has one hour a week for programming, versus 17 minutes for all other instructional activities. In addition, this activity usually involves only a handful of teachers and students, even in a large school. In about half the schools with microcomputers, only one or two teachers, at most, were regular users.

21. In late 1985 early 1986, the Department of Education and Science surveyed 500 primary and 500 secondary schools in England and Wales, and found that in the secondary schools, microcomputers were most frequently used in mathematics departments, followed by computer studies departments (DES, 1987). There is overlap here, because the mathematics departments also use microcomputers for computer study purposes. A survey of 1,000 Australian schools (Fitzgerald et al 1985) found that computers were more likely to be used across the curriculum in primary schools than in secondary schools, and that in secondary schools the dominant activities were programming (83 per cent), word-processing (76 per cent) and computer awareness (71 per cent).

22. In Scotland, a concerted national programme has succeeded in achieving much higher levels of microcomputer use in a wide range of subjects across the curriculum. It is estimated that the majority of secondary schools now have around 20 microcomputers, though some have many more. This partly reflects the availability of finance from central and local government sources, but also reflects that teachers are convinced of the value of microcomputer use, and there is a high level of demand from several subject areas. National working groups have been established to devise subject-related software and supporting curriculum materials. Innovative approaches to in-service development have been put in place at both the local and national levels. Apart from the extensive use of microcomputers in mathematics and science areas, it is estimated that at least half the humanities subject departments in Scotland now make some use of microcomputers.

23. But in most countries the levels of microcomputer use in subject areas such as history, languages and social sciences continues to be low. Insufficient hardware may be partly to blame, but the availability of hardware does not in itself guarantee comprehensive use across all subject areas. As the Scottish experience has shown, the main task for secondary schools must be to identify, develop and disseminate materials which support effective computer applications in each of the subject areas, and to design in-service programmes which give teachers confidence in using these and in adapting them to their own purposes within the classroom. The results of this experience are well documented in the HMI report Learning and Teaching in Scottish Secondary Schools: The Use of Microcomputers, which was one of the central discussion documents for the Seminar.

SECTION II

CHANGES IN CURRICULUM, LEARNING PROCESSES AND CLASSROOM INTERACTION

24. Although many practitioners are convinced that the changes associated with introducing microcomputers to the classroom are positive ones, very little careful research has been done to identify the nature of these changes (Entwistle, 1987). Such research needs to examine what happens when particular software items are used in particular ways within classrooms, and ask exactly what changes in motivation, achievement, and rate of learning are achieved and which kinds of pupils gain least or most. Certain software applications, for example, have been shown to improve motivation and student participation, but have little effect on achievement measures themselves (Entwistle 1987, Hawkins and Sheingold, 1986). Whilst software evaluation based on group data is important, there may be an even greater need to analyse how a particular software item changes individual patterns of learning. Average achievement measures may give an overall indication of the relative effectiveness of the item, but they provide almost no information on how to assist children who have hitherto been difficult to reach.

25. In one example from her fascinating and suggestive casebook, Weir (1987) describes children who are unable to manage standard mathematical computations (e.g. divide 75 by 2) but who "know" that to solve spatial problems involving this computation, the LOGO turtle should be sent 37 units across the screen. These children have the ability to solve spatial problems just by "looking" at them, but tend to do poorly at school because their abilities in the spatial domain remain undetected or are not linked to traditional academic skills.

26. In examining the ways microcomputers affect subject teaching in secondary schools, there are two elements or emphases which may occur separately or together. The first is a change in the content of what is taught, i.e. in the substance of the learning activity. New topics may be introduced, or brought down from a higher grade level, or the performance of an existing activity (e.g. computation, drawing, weaving) might involve entirely different skills. The second kind of change is methodological; self-paced learning is an obvious example, but there is also software which can be used to structure exploratory learning and experimentation, or promote group-based activities.

27. The majority of the examples discussed at the Seminar were of these two kinds; they follow a foreseeable rather than a radical path and derive from what is already accepted as good teaching practice in many of the countries represented. But there is a third path, already suggested by the "spatial learners" example above, which support forms of learning which differ in kind, not just in degree, from what was available before. This approach incorporates the results of recent cognitive science and uses powerful microcomputers to create learning environments which are quite new; they could not be envisaged without computer technology.

Microcomputers and New Learning Environments

28. The design of these learning environments usually incorporates three emphases drawn from recent cognitive research. First, this research supports the view that learning is a constructive process, that new knowledge is developed in response to experience and that its assimilation

demands sometimes painful che[illegible] ding thought structures. This viewpoint is not novel. What [illegible] important is the development of methods and theories which [illegible] testing and elaboration of how knowledge is constructed (Les[illegible], [illegible]36).

29. Secondly, investigations [illegible] these methods show that different individuals follow quite different cognitive pathways in constructing their understandings. This perspective suggests, for example, that traditional pedagogical methods may be most beneficial to children whose approach to knowledge construction is verbal rather than spatial or visual.

30. Thirdly, recent cognitive research emphasises the importance of developing an awareness of one's own cognitive strategies. The term metacognitive awareness has been used to describe the process of understanding what is demanded in a learning task, reflecting consciously on the strategies that should be brought into play, and finally monitoring the outcome (Nisbet and Shucksmith, 1986; Selmes, 1987). This aspect of teaching has often been underemphasised, leaving pupils without a clear sense of purpose or control over their learning (Brophy 1987). For example, instead of being encouraged to ask, "What should I do with this problem, and why? What useful strategies do I already know?", mathematics students are often presented with a pre-selected set of problems of a given type and told to work through them, practising a particular algorithm until the technique has been perfected. They learn to use the algorithm, but never learn when it is the appropriate one to use.

31. Based on these principles of cognitive science, a number of computer-based instructional systems or cognitive tools are emerging; these differ from standard types of tutorial software in that they do not overtly engage in instruction. Instead, they provide environments which allow learners to experiment directly with ideas, to internalise the logic of the environment with which they are interacting, to observe their own thinking, and to develop sophisticated strategies for problem solving which are potentially applicable to other areas of learning. For example, with Geometric Supposer (Schwartz and Yerushalmy, 1985-1988) students can test hypotheses about the relationships between angles and lines in triangles, polygons, and other figures and can make up their own mathematical theorems. An understanding of geometry is thereby constructed rather than received. LOGO is another, and perhaps the best known example of a computer-based discovery environment which allows learners to conduct "thought experiments" and to test the knowledge they have constructed on the basis of earlier explorations.

32. A more complete description of the emerging software systems designed to promote metacognitive strategies is available in the CERI conference report Information Technologies and Basic Learning (OECD, 1987). Unfortunately, many of the software items and approaches discussed in this report are not yet widely available in schools.

33. In relation to those cognitive tools which are broadly distributed and easily accessible, the central problem is one of conceptualising how these tools might be used within the framework of secondary subject teaching, and of developing among teachers a workable understanding of how the new cognitive science might be applied. LOGO, for example, is widely distributed. It clearly provides a powerful exploratory environment (Papert, 1980; Weir, 1987). Yet, since its relationship to the secondary

curriculum is not clear, it tends to be used mainly as a programming language within computer awareness and computer science classes.

34. On the other hand, simple word processing packages can be regarded, mundanely, as something one is taught to use in business studies, or more radically, as a cognitive tool for reflecting on writing. Used creatively, the word processor can shift the emphasis from composition to editing; the components of the act of writing and the strategies for assembling a complex network of ideas and rearranging them into linear text can be made more visible, particularly if the production of the text is treated as a collaborative act within the classroom.

35. It is likely that the most powerful contribution of computers to learning in the future will depend on the development and dissemination of cognitive tools such as those briefly described above. Yet even in the absence of such highly sophisticated software, it is evident that some changes in the cognitive basis of learning have started to occur, and that microcomputers are having very significant effects on curriculum content and on methods of classroom management in most of the countries represented at the Seminar. The next two sections address these topics, and the final section outlines the Seminar's conclusions on the implications for teacher education.

Classroom Management and Learning Interactions

36. There is nothing simple or direct about the impact of microcomputers on patterns of classroom interaction. To begin with, classrooms represent particular cultural choices about how learning can best be socially organised. These choices are constrained by shared expectations as to how teachers should interact with students, and how students should interact with each other. Such expectations partly determine the kinds of educational reforms that are regarded as desirable within a given system. At the same time they influence choices about matters such as hardware configurations, software development and teacher education.

37. At least two cases were identified where teachers in different countries seemed to react very differently to options for changing interaction patterns in the classroom. The first case involves promoting group work as a learning mode, and the second concerns the extent to which students might take some responsibility for teaching each other within the classroom. Whilst changes in these directions were regarded as desirable reforms in some systems, this view was not universally supported.

38. Videotapes and descriptions presented at the Seminar suggested that in many schools in Australia, Canada, United Kingdom and United States, benefits were seen in encouraging two or three students to work together at each microcomputer station. A lot of transfer of technical and substantive knowledge seems to occur at the computer interface within small groups, and at the same time the students learn to co-operate and jointly develop communication and problem solving skills. Educators in these countries have long believed that group interaction should produce cognitive gains, but these did not always materialise (Entwistle, 1987). In these school systems the capacity of microcomputers to help structure group work is seen as one of their distinct benefits (Hawkins and Sheingold, 1986; SED, 1987).

39. Emerging practices in Japanese secondary schools reflect a different philosophy. Whilst microcomputers are not yet widely available, the purpose of initial experiments seems to be to encourage students to work alone in computer based learning environments, and to venture solutions to problems without seeking the support of other students. The hardware configuration chosen for these experiments in Japan provides one microcomputer station for each pupil.

40. The French National Plan represents another variant, in which each school was provided with a network of microcomputers and one "master" computer. As already mentioned, the Inspectorate report (June 1985) found that teachers were reluctant to use the equipment because the numbers of workstations were inadequate for whole-class teaching. An alternative approach, favoured in some schools, is to allow individual students to use the laboratory on a "self-service basis" to work their way through programmed material, either in their own time or when released from lessons. With this approach there is no intention of changing the method of classroom management. Instead, the microcomputers are used for the individual mastery of particular skills, as an adjunct to classroom lessons.

41. But in France, as elsewhere, the main thrust of the more recent teacher education programmes is to encourage teachers to develop ways of integrating microcomputer use into normal class lessons in all subject areas. It is evident that, unless one microcomputer station is provided for each student, or unless students are required to queue for the computer and are told not to discuss their work, microcomputer use will lead to much more communication among students.

42. A United States study using time-sampled observations of student interaction (Hawkins et al, 1982) showed that students collaborated more when they were working on microcomputer programming tasks than on other classroom tasks. This comparative difference was consistent over time and different classrooms. Some students acquired particular expertise with the language; these became expert consultants who advised other students on programming problems. This kind of role differentiation was also observed in studies of Australian classrooms (Firkin et al, 1985). A number of delegates at the Seminar noted that this phenomenon was a source of anxiety for many teachers, who fear that they are no longer in charge of their classes, because the students know more than they do.

43. Taken-for-granted assumptions about "being a teacher" are thus called into question. Apart from the technological knowledge required, teachers are being asked to revise some of their basic attitudes, and are finding that their usual methods of whole-class management are no longer serving them well. The implications of these changes for the structure and duration of teacher education activities will be discussed in the final section.

44. Microcomputer use entails changes in classroom management which affect teachers in all subject areas. At the same time, there are a number of subject-specific changes, which may be considered under four headings:

- The introduction of new technology subjects;
- Changes in the cognitive content of traditional activities;
- Inclusion of new activities and topics in existing subjects;
- Increased use of learning processes based on exploration, discovery and model building.

45. Examples presented in this section illustrate some of the changes occurring in subject teaching under each of these headings. Most of these examples were presented or discussed at the Seminar; there is no significance to the selection according to country, nor should they be regarded as the best available examples in each category.

New technology-related subjects

46. As already discussed, the creation of new subjects such as computer awareness and computer science represents the most conspicuous change in secondary school curricula associated with microcomputers. Several countries have introduced computing as a final-year secondary option, and in France, Lycée students may choose informatics courses based on either linguistics or programming, though neither are compulsory.

47. With Computer Numerical Control (CNC) of Machines, Computer aided Design (CAD) and Computer Aided Manufacture (CAM), a certain number of the key skills which once formed the core of technical education have virtually become obsolete. Consideration of the challenge of reviewing the skills of teachers in the vocational education sector was beyond the scope of the Seminar. Nevertheless, the extent of change in the nature of intellectual work in the world outside the school means that standard approaches to even basic activities, such as writing and computation, need to be radically re-examined.

Changes in the cognitive content of traditional activities

48. Delegates concerned with mathematics teaching indicated dramatic changes in this field arising from two sources. First, there are changes in the nature of mathematics as it is practised by professional mathematicians, and as it is applied in areas as diverse as engineering, electronics, business and finance, linguistics and sociology. Second, the availability of a wide range of tools, from sophisticated pocket calculators to exploratory mathematical environments, means that many of the customary ways of solving mathematical problems have become irrelevant and inefficient.

49. Solving conventional textbook problems has traditionally demanded accuracy and patience in following through tedious algorithms, and the mental gymnastics involved in doing this tends to absorb most of the mental energy young people bring to this subject. Delegates noted that the use of microcomputers in mathematics teaching provokes profound questioning of what it means to know mathematics. If "getting the answer" is becoming so easy that anyone can do it, then teachers will

need to develop more accurate ways of finding out whether or not the student has grasped the concept.

50. This shift in focus away from mechanical activities towards higher order skills is also evident when microcomputers are used to support process writing. More time is spent on researching ideas and organising text. The tedium of rewriting is eliminated; revision becomes highly efficient and more rewarding. The mechanical aspects of editing can be handled by the computer, leaving the teacher free to discuss the more complex and creative aspects of the work with the writer.

Inclusion of new activities and topics in existing subjects

51. In presenting examples of new activities and topics being introduced in various countries, delegates illustrated many ways in which the content of subjects is changing with the creative use of microcomputers and peripherals. In some cases, there is an increased emphasis on a particular aspect of a subject; e.g. more quantitative topics in geography (SED, 1987). In other cases, microcomputers are providing the basis for the production of goods of a commercial quality within the school, which means that the curriculum is gaining a far greater sense of relevance. The following are some of the applications described by delegates.

52. In the Scottish certificate of sixth-year studies, a macro-economic simulation model is used for both teaching and assessment in economics. Students are given an eight-year history of the British economy which indicates how it has reacted to past policy decisions. They are required to evaluate the effect different monetary and fiscal decisions would have, and they can test their hypotheses by presenting these choices to the computer. The model rapidly computes the effect of these decisions so that in about half a day, roughly ten years working of the economy can be simulated (SED, 1987).

53. Designing and weaving tapestries is a traditional activity in Norwegian secondary schools. Done by hand, this work is slow, and the weaving is tedious if the pattern is complex or contains many colours. The weaving programme is a subject related tool for the pattern composition and texture analysis. It has been developed for vocational education in upper secondary schools and colleges, and is used both for creating designs and producing tapestries. Looms of different sizes can be attached as computer peripherals, and 125 different colours can be used. A new set of exacting skills are involved, and the students must have a thorough understanding of the materials themselves. The main advantages are that much more energy can be directed to the aesthetics of design, and the products are thoroughly professional.

54. Music is another subject in which microcomputers have had a considerable impact on content. Since most students have not mastered a conventional musical instrument, activities such as composition, and even the reading of musical scores, are not accessible to them. Now a variety of sounds and functions can be produced by microcomputers using a Musical Instrument Digital Interface (MIDI) and an electronic keyboard. In Scottish schools, a programme which uses the sound and graphics features of the microcomputer is used to teach aural discrimination score reading. A tune appears in staff notation on the screen and then is played by the computer, but with one note different from the screen display. The student has to identify the deviant note. Using similar

software, students are able to compose and practise music on their own (SED, 1987).

55. The production and printing of monographs, magazines and newsletters is an obvious area in which school students are now able to develop products of a professional quality. For example, using word processors and desk-top publishing equipment, it is no longer necessary for the school magazine to be sent out to a commercial printer. A number of related applications introduce students to the problems of news reporting using limited factual information, opening questions of media bias and the politics of the press.

56. For example, the State Education Department of Tasmania (Australia) has taken a subscription to Reuters International News Service. Project schools receive daily telexes through the Department's head office. Students use the telex information to write a news story related to some major international event, and the following day they examine the local press to see how the same information was interpreted by professional journalists. A related U.K. programme - "NEWSROOM" - also aims to develop writing skills and a critical awareness of current affairs.

57. Whether one is dealing with writing and publishing, weaving, music making, computation, or graphics, there is a danger that the widening gulf between the way these things are done in the real world, and the traditional methods used in schools will generate a sense of frustration with a curriculum that must be seen as tedious and irrelevant. The examples given above (there were others that we do not have space to describe) illustrate how the content of school subjects is changing to reflect the new methods of intellectual and material production that are now becoming commonplace in the world outside the school.

Increased Use of Exploration and Discovery Method

58. The idea that students should construct their own understandings of complex concepts through experimentation and discovery is an old one which has often proved fertile. Yet at the same time it has never been fully accepted. The sceptics case is partly built on a reaction against those advocates of discovery learning who seem to believe that students can reconstruct within a few days concepts that great minds took years to devise. In addition, it has proved to be very difficult in practice to simultaneously guide discovery and leave space for exploration. As a result, a false dichotomy has arisen, in which discovery approaches are seen as creative but unstructured, whilst the academic rigour of traditional instruction is implicitly devalued.

59. Discovery learning has also proved difficult for practical reasons. Even in mathematics and science, where concrete aids such as Cuisenaire rods and laboratory equipment are readily available, teachers have found the experimental approach both limited and difficult to manage. Most students do not have the techniques and skills to obtain accurate results. Developing these skills should not become an end in itself, and in any case many of the experiments would take too long to perform. In other subjects (eg geography, geology, economics) some of the phenomena being studied do not lend themselves to experimental manipulation under the conditions available in school laboratories.

60. Several examples of software which aim to structure discovery learning were presented at the Seminar. Videotapes were presented

showing how computer-based teaching modules are being integrated into existing curriculum and practice. Three examples are described below: a sophisticated multi-media package for teaching ecology and other scientific concepts, software which stimulates a complex laboratory experiment, and exploratory activities in history which makes use of simple database packages.

61. The Voyage of the Mimi (Bank Street College, United States) is a multimedia package which includes a series of dramatised television episodes, documentary film, a 160 page student book, a teacher guide and three software packages. During the course of an exciting whaling expedition a whole series of concepts, operations and factual information is introduced involving whales and their environment, meteorology, navigation, chart-reading, repairing a ship and so on. In the episode presented at the Seminar, the crew (all teenagers) were marooned on a desert island. In order to survive they had to gather or trap food, collect wood for cooking and warmth, and build shelters. These ideas are introduced through a video drama. The related software, which takes the form of an adventure game, is based on a simulation if the island's ecology. The game involves choices about survival strategies and indicates the consequences of different decisions (eg concentrate on trapping rabbits and don't build shelters) for both the ecology of the island, and the short and long term survival of the group.

62. Through Project-Inquire the Bank Street College is producing software which aims to make the process of inquiry more explicit. It contains three modules; the first is a brainstorming aid, where initial questions and hunches are sketched out. The second is a kind of "electronic notebook" which allows a learner to enter ideas and data, and to organise, reorganise, inter-relate and search them. The third provides a battery of tools - numerical, graphical and qualitative - for analysing the information that has been recorded in the notebook. This software begins by valuing the students own questions; it demands effectively structured group work, and places the teacher in the role of an "inquiry coach". Especially for secondary subject teachers, such work is challenging. To allow students to complete a purposive activity they may need more time than the standard lesson period allows. Teachers themselves must enter into the puzzlement that is central to the transformation of knowledge and the construction of personal meaning.

63. The second set of examples illustrate the use of simulations and interfacing to allow students to conduct experiments which would otherwise be too difficult, time consuming or even impossible to conduct. A typical case, versions of which are used in a number of countries, is the simulation of Milliken's experiment, which is used to demonstrate the discontinuous nature of electric charge, and calculate the magnitude of the charge of an electron. In the experiment, a charged oil drop is held between two metal plates by an electrostatic force. The size of the voltage used to produce this force, the separation of the plates and the mass of the oil drop are used in calculating the charge on the drop. The process is difficult and time consuming, but the logic of the inquiry can be retained by using realistic animation graphics on the computer screen. These present a schematic representation of the apparatus; the student is able to simulate different voltages across the plates by typing in commands. When the gravitational and electrostic forces on the oil drop are in equilibrium, it appears stationary, and the voltage reading can be taken from the screen. Pupils can then calculate the charge in the oil drop from data that the computer makes available.

64. Another application which greatly extends the range of experimental activity that can be managed in the school laboratory is the use of computers interfaced to suitable sensors for collecting data. This allows the recording of extremely small changes in variables, simultaneous measurements of several factors at once, or recordings of change which occur very quickly or very slowly. An example used in science classes in Scottish schools investigates the rate of reaction of an acid and a carbonate by placing the chemicals in a vessel on a balance that is interfaced into a computer. A graph of weight against time is displayed on the screen and, by examining the gradient of the graph, the rate of reaction can be determined at different points during the chemical reaction. The automatic logging of the data allows the small changes in weight to be continuously monitored and the graphical display of the results enables the identification of important principles underlying this experiment without the pupils being distracted by plotting graphs.

65. A third illustration of the way microcomputers are being used to structure inquiry based learning is the use of data-bases in history. The Australian Computing History Project (CSC, 1986) involved the formation of a specialist team of practising history teachers who supported each other in developing ways of integrating existing history software into the curriculum. Over a period of twelve months the project produced a curriculum kit containing case studies, curriculum units and teaching ideas for a range of history software, and a professionally produced videotape depicting four different school environments and four different software applications. The video, which was presented at the Seminar, documents real classroom experiences and direct observations by teachers (and students) on these experiences. Being a dynamic medium, videotapes demonstrate far more clearly than printed materials can how enquiry learning might be structured and supported in the classroom.

66. A central goal of the project was to establish a model of professional development for computer use across the curriculum. Although Australia had created a large amount of history software, most of it had been produced without consideration of curriculum and practical teaching issues. It was therefore being used mostly by computing teachers to teach computing, rather than by history teachers to teach history (Wills et al, 1985). The project selected twenty teachers who traditionally had not had access to the school's computing facilities and selected a subject that traditionally has attracted more female than male teachers. All the teachers were strong on curriculum writing experience; they were not selected for their computer expertise.

67. Computing History provides an important model in which the curriculum development and teacher education components seem almost inseparable. It raises many issues that will be taken up in the next section; the stages and processes of teacher education for microcomputer use, the relationship between software development and the development of course materials for integrating the software into the curriculum, and the kinds of support that teachers need as they begin to struggle with new styles of teaching and learning in their classrooms.

SECTION III

TEACHER EDUCATION FOR MICROCOMPUTER USE

68. The examples presented in the last section illustrate how microcomputers can be used to support an increased emphasis on exploratory learning, or a shift in focus towards higher-order analytical activities. Microcomputers have also been used to introduce new topics such as simulation in macro-economics, or composition in music. In addition, instead of labouring through outdated procedures which have no relevance to real-world activity, students can now produce professional results with tools such as desk-top publishers, or pattern-making software and weaving peripherals.

69. This review has not been exhaustive, yet it clearly demonstrates that the changes in teachers' knowledge and skills associated with microcomputer use are enormously broad. Whilst all of the applications described demand at least elementary competence in using microcomputers, the new learning required for effective computer use goes far deeper than this. Many teachers will have to master new subject matter, and most will need to develop different strategies for managing classroom organisation and interaction. Some applications (but not all of them) challenge teachers to reconstruct the practical theories they use for understanding the learning process itself.

70. This discussion raises an important question about the nature of computing as an innovation, and its implications for teacher education. Should the professional development of teachers in educational computing provide a new way of doing the things they have always done, or should it help teachers to do different things?

71. At the Seminar, examples of both kinds were considered, and it became apparent that we were dealing with four components of change:

71.1 The possible use of new materials or devices for teaching existing topics;

71.2 The possible introduction of new topics which depend on the use of new materials and technologies;

71.3 The possible development of new teaching methods or strategies;

71.4 The possible alteration of beliefs (i.e. pedagogical assumptions and practical theories about teaching and learning itself).

72. Some of these changes will be more difficult to achieve than others.

73. Teacher's practical theories, for example, embody all that they "know", on the basis of their stored past experience, about how to teach their subject, manage the classroom, and deal with individual learning problems. The reconstruction of such procedural knowledge is a slow and painful process. Withdrawal from the school for a short formal course at best provides a starting point. If this is not followed by opportunities to practise the new skills in a supportive school environment, the initial effort can easily be wasted.

74. For all Member countries, the challenge of providing effective teacher education for microcomputer use will prove to be enormous, because of the scale of the operation, as well as the complexity of the changes involved. It is only relatively recently that most countries have started to develop systematic teacher education programmes that go beyond elementary training in computer use, or aim to deal with pedagogical change and the needs of teachers in particular subject areas.

75. With the exception of Scotland, the Nordic group and France, only a small proportion of subject teachers in most Member countries have been able to participate in-service courses on the educational use of computers. There is also some evidence that in many secondary schools, computer awareness and computer science teachers are the only ones to have received anything like an adequate formal training in computer skills. For example, as part of a survey of the work of the Microelectronics Education Programme (MEP) in the United Kingdom (DES, 1987), more than 30 in-service courses were visited. The majority were short courses of one to three days duration, but there were also some longer courses (of about 150 hours) and one MEP mathematics course. It was found that most of the participants on the longer courses had responsibility for information technology subjects in their schools, and for passing on training to others, in keeping with the "cascade" model. Unfortunately, some of these teacher leaders were unable to obtain sufficient time on their return to school to continue the "cascade".

76. An Australian evaluation report (Deakin, 1987) identified similar problems:

> "At the beginning of the National Computer Education Programme (NCEP), there was a scarcity of teachers who understood anything of the use of computers in schools, who could be of use in a professional development programme. The marriage of this scarcity with the system-level administration of funding for the programme led, almost inevitably, to a kind of managerial-hierarchical approach to in-service education. In this model state computer centres became the source of expertise and personnel in the provision of professional development for teachers" (page 43).

77. In all three States involved in the evaluation, the most frequent model of in-service education was the removal of teachers from schools for short courses of one day to six weeks in duration. The longer courses were for teachers who would be responsible for computer developments and in-service work in their own schools. According to the evaluation, these one-off experiences were frequently reported as being of little value. Long courses were clearly more effective in terms of the teacher's own learning, but it was found that unrealistic expectations were often placed on these teachers to train others, without any reduction in their teaching load, when they returned to their schools.

78. Another feature of this hierarchical approach to in-service education was the assumption that teachers of all subjects, from many different kinds of schools, could be equally well "trained" by doing courses which principally focussed on the technology. These courses ignored the different needs of the participants, and did not draw on the range of experience they brought with them to the workshops. The Australian report characterises the State computer centres as "schools for teaching computer literacy":

"The emphasis in such courses is the technology itself, the computer hardware and software, rather than upon the use of computers in schools. The assumption behind a "computer literacy" approach is that it will allow teachers to gain access to computer hardware and software (for both themselves and their students) and once they have the experience of using computers, they will be able to address the higher level issues of using computers in educationally useful ways" (Deakin, 1987, p.49).

79. For most countries little quantitative information exists concerning the extent of the unmet need for in-service courses in educational computing. The Nordic countries have produced impressive statistics; for example, it is claimed that 95 per cent of Danish upper secondary teachers have completed a 20-lesson course at their schools, and that in Norway most teachers have done a basic one-week introductory course, and some have completed the second stage which deals with subject specific software applications. In Iceland a 40-hour course is provided during the summer; it has been taken by over one-third of the country's 2750 compulsory level teachers. In France, one quarter of the teaching force had received some training by June 1985, even if it was narrowly focussed on machine operating skills. A report on computers in Dutch secondary education prepared for the Seminar (Nagtegaal & Scholtes, 1987), indicated that by early 1987 fifteen per cent of Dutch teachers had received some training, but again, this was mostly through introductory courses in computer studies and computer literacy. But in every case, where such data are available, country reports show that the demand from teachers for courses in educational computing greatly exceeds the supply, even when commercial courses and university courses are included.

80. Yet at the same time, short courses on computing are at best a first step towards effective classroom use. Experience in various countries, Scotland in particular, has demonstrated the value of subject-specific professional development, which focusses on the integration of computer applications into existing courses. But there is also a need for professional development activities at the school level. A range of strategies is available for meeting these needs. Pre-service education, various approaches to in-service provision, and the need for continued support after in-service were all considered during the Seminar. The remaining sections of the report summarise these discussions and outline a number of areas where common agreement was reached.

Pre-service Professional Development

81. The provision of computer education units within pre-service programmes was discussed only briefly at the Seminar. Whilst the introduction of such units is important, it was agreed by delegates that for the foreseeable future, pre-service provision is unlikely to make a significant contribution to the effective classroom use of microcomputers.

82. There are two reasons for this. Firstly, the only major OECD country that has a serious shortage of teachers at this time is the United States. The demographic conditions in almost every other Member country are such that the rate of recruitment to teaching is very small, so that in numerical terms new recruits are unlikely to have a major effect on patterns of educational practice in schools for some time to come.

83. The second problem is more complex. It relates not only to the issue of retraining the teacher trainers, but also to the problem of how knowledge about the effects of microcomputers on learning is created and legitimated. It would be relatively easy for universities and colleges of education to recruit computer scientists and launch courses dealing with programming and machine management. The survey conducted for the Seminar indicated that in at least eight Member countries such courses are either a compulsory or an optional part of pre-service development, and three other countries are moving in this direction. But if these courses are introduced in the absence of any real changes in other aspects of the pre-service education, it will mean that beginning teachers will know how to use computers, but will not know anything about how computers might change the nature of the learning process in their own subject area.

84. To overcome this, it will be necessary to work towards ensuring that <u>all</u> faculty members responsible for pre-service education are fully cognisant of the software applications appropriate to their subject areas, and of the ways these may best be applied in classrooms. This may not be possible for some time. The most disturbing feature of our present stage of development is that it is the teachers themselves who are pioneering new approaches to practical pedagogy. What is needed is not just subject knowledge, but knowledge about how students might learn that subject in computer enhanced environments. Knowledge about how these environments work is only slowly being developed; it is being created at the classroom level by teachers who are acting as researchers, analysing the actual effects of different software packages, and experimenting with alternative ways of using them.

85. It was <u>agreed</u> by the Seminar, that in addition to knowing their subjects, teachers and teacher educators need to understand the nature of the learning processes that are specific to their subjects. This understanding is needed to guide the selection of software and the development of effective ways of using that software in the classroom.

86. The Seminar <u>noted</u> that videotapes which record the new understandings teachers are constructing, and which demonstrate changes in teaching strategy and classroom organisation, are particularly valuable in conveying the nature of these changes to teachers, as well as to parents and employers.

87. It was recognised that at this stage, these skills required to advance educational computing are most likely to be found among practising teachers. As the next section makes clear, in-service and curriculum development efforts depend very heavily on their expertise. Yet they are frequently expected to provide peer support and assistance without any release from full-time teaching loads. Their contribution to action research and software evaluation is critically important, but is often undervalued. It was agreed by the Seminar that the special role of classroom teachers in professional development, curriculum development and research on microcomputer applications should be explicitly recognised; that such activity should be supported by appropriate time release, that the status of teachers as researchers should be acknowledged and their contributions should be encouraged by promotion (or promotability) and formal credits.

88. Whilst self-teaching and experimentation are essential for developing effective ways of using microcomputers in the classroom, this usually does not begin until the teacher has completed an introductory course. Further development depends on the availability of hardware and software, and a supportive learning environment. The next two sections describe alternative ways of providing these conditions; first, through organised in-service activities, and second, through a variety of arrangements for continued support after in-service.

89. In-service courses for microcomputer use are usually organised in one of three ways; through short courses provided away from the school, through formal arrangements within schools and through the organisation of working groups associated with particular subject areas. Some systems use a mixture of all three arrangements.

Formal short courses

90. This was the first, and it remains the most conspicuous form of in-service development. In a survey conducted by the OECD in 1983, it was found that 9 of the 24 Member countries had started to provide short in-service courses; these mostly emphasised programming skills and machine management. Some of them introduced tool packages such as word processing and spread sheets, but little detailed work was available on particular subject applications (CERI/NT/85.03).

91. The survey conducted four years later in preparation for this Seminar (CERI/TE/87.04) found that most of the 24 Member countries are now providing in-service activities, but the combination of formal short courses and the "cascade" model of dissemination still dominates. Although detailed information is not always available, short courses seem to be the main method used by 16 of the 20 countries that responded to the questionnaire. Two of the Nordic countries use school-based programmes as the dominant mode and two countries provided no data on their in-service activities.

92. At the same time, the survey suggested that some of the earlier problems associated with short courses are slowly being overcome. For example, in Scotland the colleges of education ran courses for their own staff to develop their expertise in microcomputer applications in each subject area. Scottish Education Department policy encourages college lecturers in all disciplines to run courses which focus on pedagogical issues, making use of computing staff as required. Similar training programmes for teacher trainers are occurring in Swedish universities. In Quebec, the Ministry has designed (and provides through universities) courses for teachers which focus on software selection and reflective research on microcomputers and teaching practice. In France it has been declared that the next phase of the Informatique Pour Tous programme will involve more "self-training", and that a pedagogical emphasis will replace the focus on programming that characterised the first stage. In Australia, the United Kingdom and the United States a wide range of alternative activities is emerging, and in various countries, including Scotland, Norway and the Netherlands, a multi-stage approach has now been defined in which computing skills are merely the first step.

93. Introductory short courses clearly carry a legitimate role, but their value is often lost because the teachers who have been through the

courses cannot gain access to computers when they return to their schools. Since both the courses and the hardware are scarce, it is highly inefficient to grant access to one and deny access to the other. Therefore, there needs to be some kind of co-ordination between the decisions made by the course organisers as to who should enrol, and the decisions made in schools about who will use the hardware.

94. The Australian evaluation study describes a clear example of this kind of mismatch. Consistent with the National guidelines, course organisers in all the States were required to follow a policy of reserving computer education in-service places for non-mathematics and science teachers, and giving preference to female teachers. But in many of the schools, the computers are all in a high security room in the mathematics area. The report cites a case in which mathematics-science teachers who were experienced computer users were excluded from in-service courses, whilst female teachers returning from the courses had to provide support to novice users, in a context where they did not have easy access to the necessary equipment.

95. The policy adopted under the Dutch NIVO project provides one possible solution to this problem. Under NIVO all schools which meet certain conditions will be supplied with 11 free microcomputers; one master, a printer and eight slave stations linked in a local area network, plus two extra computers to be used outside the computing laboratory. In order to qualify for this donation, schools must meet the condition of having three teachers who have completed a training course, of whom one must be female. There are two types of courses; those aimed at computer studies and information science teachers, and those which support the use of microcomputers in subject teaching.

96. An alternative approach for achieving efficient use of resources is to locate teacher development, as well as the decisions about hardware configurations and software packages, within the schools themselves.

School Based In-service Development

97. To make effective use of microcomputers across the curriculum, it is necessary that a school simultaneously acquire an adequate quantity of software and equipment, as well as training for a substantial proportion of the staff. Since resources are never unlimited, decisions also need to be made about issues such as priority curriculum applications and strategies for ensuring that the computers can be used by teachers from all subject departments.

98. In Norway, responsibility for computer purchase and in-service provision lies with county authorities for upper secondary schools, and with the municipality for lower secondary schools. The central government might contribute to costs for vocational education or for experimental activity, but overall decision-making tends to be local and decentralised. Following the abolition of the National Council for Innovation in Education, the Norwegian Parliament has explicitly adopted a decentralisation policy under which the responsibility for school development will lie with the schools themselves. (OECD: Norwegian Examiners' Report, 1987).

99. Thus, when the Parliament set broad guidelines for the Programme of Action all the pilot schools involved in the experiment were required to establish their own specific project ideas. In each of the 24 pilot

schools, all the teaching staff completed a 40-hour intensive school-based training programme. During this programme the school staff as a whole was required to agree on a concrete policy for computer applications across all areas of the curriculum.

100. Investigations prior to the Programme of Action indicated that about 70 different brands of computers were being used in Norwegian schools, and that little software existed to support applications across the curriculum. There was concern that in a country as small as Norway, the uncritical introduction of computer technology into the schools could undermine the culture, since both standard computer language and most of the available software is in English or other foreign languages. In 1983/84, educational specifications were developed and contracts were signed for the delivery of Tiki and Scandis computers for use in the pilot schools; a Task Force was established with broad responsibilities, one of which was the development of software; and all the nation's schools were invited to apply to participate in the experiment.

101. The Programme of Action was designed to provide the basis for the development of computer competence in all Norwegian schools. It was stressed that "neither the activities under the Programme of Action nor the general introduction of computer technology in schools must in any way lead to a disturbance of equality between sexes", and that "an important political objective for the Norwegian school system is to avoid creating new class distinctions" (Examiners' Report, p.49). Pilot schools were therefore selected in a way which guaranteed the inclusion of all social classes and ethnic groups in the experiment and negotiations were held with teacher unions on the terms for teachers' participation in project activities.

102. The role of the pilot schools and the project schools (these 16 schools participated in a reduced way), was central to the design of the Programme of Action. The goal was to develop high levels of competence within these schools, to use the schools for software evaluation, to involve them in a continuing process of development and evaluation of effective classsroom strategies. The experiences gained in these schools are to provide a knowledge-base to be communicated to the Norwegian school system as a whole.

103. In evaluating the Programme of Action a number of results were noted. In particular, it has increased interest and activity in teacher education, and it seems to have:

> "...shaken up the school as an organisation. A new medium has made its way into school, which, long term, will involve even further demands for change. This concerns both the curriculum, the instruction, the learning activities and the traditional student- and teacher-roles..." (Examiners' Report, 1987, p.67)

104. The Norwegian Programme has been described in some detail, because it provides a model of a national development strategy which is designed to provide teachers with the conditions which allow them to develop new pedagogical understandings, which can then be used to advance effective practices across the system.

105. An alternative model for bottom-up (as distinct from top-down) development depends on the formation of supportive groups of subject teachers.

106. In most countries, early courses aiming to promote microcomputer use in particular subject areas suffered from a lack of appropriate software. It was therefore common at the beginning to introduce teachers to programming and to encourage them to produce their own software. Experience has proved that this is not an effective method of software development. At the Seminar, Louise Dubuc, who is responsible for both teacher education and software evaluation within the Ministry of Education in Quebec, described her experience in relation to this issue:

> "In a course on Computer Assisted Learning I used to give to teachers, I asked them to design and programme a pedagogical idea. The first part of the work was to prepare a scenario on paper. Many pedagogical jewels emerged. But at the programming stage, these jewels melted into dull software because of limited competence in that domain.
>
> The prime interest of the teacher is in pedagogy. Good teaching for efficient learning is the aim. But when asked to programme, teachers are put in a situation where the majority of their efforts are channelled towards looking, not at the target, but at the sight. This is surely not a desirable way to train someone in the use of computers in the classroom" (Dubuc, 1987, p.2).

107. Software production clearly demands a high level of programming skill, and this is a specific talent. Experience now shows that better results can be obtained by establishing partnerships between programmers and subject teachers who are experienced in curriculum development. These partnership themselves constitute a form of in-service development; those who have participated in them are qualified, as a result of their experience in developing and evaluating software, to act as expert teachers in either regional or school-based in-service activity.

108. But the production of good software is not the end of the story. Studies on the introduction of computer-based tools into the enterprise sector have noted that, in contrast with conventional tools, these new tools lend themselves to a wider range of possible applications, and that they tend to be adapted by those who use them to achieve a closer fit with their objectives. At the same time, these changes in production processes usually demand changes in structural relationships among workers themselves and new forms of work organisation (OECD-CERI, 1986). There is therefore a two-way malleability; of the microelectronic tools as they are adapted to the objectives of the firm, and of the organisational arrangements in response to the technology and the new methods of work.

109. This two-way malleability is also evident in the classroom (Hawkins and Sheingold, 1986). The best way of using a particular piece of software to support student learning only becomes apparent through trial-and-error processes which result in the modification of both the <u>organisation</u> of learning associated with a particular piece of software, as well as changes in the software itself or the way it is deployed. We have already noted that many software items (e.g. word processing tools) lend themselves to multiple uses, some more imaginative than others. The production of curriculum packs which indicate effective ways of using

software has been welcomed by teachers, even though they may wish to adapt these further for their own classroom use. This approach is perhaps more evident in Britain, Australia and the Nordic countries than in the United States, where software and other media are produced and packaged by research organisations and/or commercial agents, rather than by groupings of subject teachers.

110. Thus, a second type of participatory in-service activity has emerged, where teachers who have pioneered effective software applications are given extended release from teaching to produce curriculum packs containing teacher guides, software disks, student worksheets, references to related print material and sometimes videotapes for classroom use. Some teacher-education videotapes have also been produced to demonstrate alternative forms of teacher-student and student-student interaction and class organisation.

111. In Scotland, the Education Department (SED) and the Regional Authorities (LEA's) have been active in both areas. First, software specification and development has been the objective of a number of nationally organised in-service activities. These have mostly taken the form of "immersion" courses of around one week in duration. For example, in one course, 50 geography teachers from all over Scotland came together to produce curriculum ideas. They were divided into groups of 6 or 7 and a programmer was allocated to each group. The coding was done overnight so that specifications could continue to be written the next day. Although further debugging was required, the programmes were up and running by the end of the week. An important feature was that the teachers were also asked to produce teaching materials and questions to test student understanding of the topics covered by this curriculum package. The approach initially adopted by the geography teachers has since been taken up by the other humanities subjects; history, modern studies and economics. Further developmental work was done in each case to improve the software discs, and to assemble comprehensive kits including explanatory "starter papers", teacher guides, reading lists and related commercial software. Videotapes showing effective teaching strategies for using the curriculum kits were also prepared and made available as additions to these packages (Hunter, 1987).

112. A prominent feature of the Seminar was the display of videos from this programme and from similar programmes developed in other countries. The Seminar agreed that videotapes provide a particularly valuable way of conveying the understandings gained from such action research, and demonstrating the changes in classroom management and interaction which are occurring. The need for banks of such video material was noted, and the possibility of international exchange of videos was supported, on the grounds that this medium is almost uniquely suited to displaying the complexity of classroom activity and the specific contribution of microcomputers in this context.

113. The production of software through teacher partnerships is now a well established model in Scotland. The Scottish Council for Educational Technology works together with groups of teachers drawn from various regions to specify packages. It then produces the programmes which, after modification and testing by teachers, are circulated to local centres. The agreement between the Scottish Microelectronics Development Programme and the local authorities is for free distribution to the local centres and thereafter free distribution by the centre to local schools.

114. Whilst the development of software in Scotland is co-ordinated nationally, the Regional Authorities are active in developing curriculum packs to support this software, and in conducting in-service activities to help teachers make use of these packs in their classrooms.

115. In the Lothian region, for example, training packs designed to support the classroom use of computers in a number of subject areas were produced by a project which involved eleven teachers seconded for one term, and two professional support staff. The teachers were asked, in relation to their own subject areas, to evaluate available software and associated materials in order to identify what was suitable. They were then asked to develop a training package, test it in a school, and make appropriate improvements. Finally, they were to provide training for teachers making use of the package, and distribute the packages at the end of the course.

116. This project aimed to reach every secondary teacher or college lecturer in each of the eleven subject areas chosen; the objective was achieved by preparing enough copies of the packs to ensure that they could be given to subject teachers in all 51 secondary schools in the Lothian region. Every subject teacher in the region participated in an intensive in-service provided by the training teacher who had produced the pack. This involved seconding the training teachers for an additional week, during which they presented the pack to small groups of teachers in five consecutive one-day sessions. During the Seminar, examples were presented from several countries demonstrating the importance of involving teachers in software specification, formative evaluation, research and in-service development for other teachers.

117. It was agreed that high priority should be given to supporting more action research in secondary classrooms, to identifying effective ways of using particular pieces of software, and to producing broadly based evaluations of the changes in student learning and motivation which result. The Seminar also agreed that the involvement of teachers in software specification should be supported, but that it was not appropriate to expect teachers to program their own software.

CONTINUING DEVELOPMENT

118. It is only when teachers have completed their introductory short courses and have started trying to use microcomputers in their classrooms that the really difficult and important aspects of their education begins. This complex technology does not lend itself to instant or pre-determined results. In the right context, it can support the slow transformation of the cognitive and social basis of classroom practice. But this does not happen automatically. It demands that teachers engage in a conscious effort of reconstruction, in which their procedural knowledge about classroom practice and their theories about the nature of learning itself are challenged.

119. All of this occurs best when it is possible to provide a supportive learning environment within the school, advisory structures and support networks to link schools with each other, and a multi-stage approach to organised development activities. The functions of support networks have already been illustrated by projects such as the Australian Computing History project, and the two Scottish curriculum projects described in the last section. Discussion of the other two issues is reported below.

After In-service: Learning in the School

120. As part of the Norwegian Programme of Action, an evaluation was made of the factors that lead to successful teacher development at the school level. Four factors were identified:

- The attitudes of the school principal;
- The extent to which teachers were able to sustain practice after initial training;
- The degree of mutual support among teachers;
- The availability of written material giving advice on effective software applications.

121. The Australian evaluation study also found that the one-to-one coaching of teachers by each other was probably the most useful form of learning, but that it was not properly acknowledged. Computer-competent teachers were almost never given adequate time allowance to offer this assistance.

122. Sustained practice depends on arranging for all teachers to have access to both hardware and software. Often the software which exists in a school is impossible to locate because it has not been catalogued. The Seminar noted the need for teacher-librarians to be encouraged and supported in dealing with this problem.

123. Problems of access to hardware are more difficult to solve, with different approaches being adopted in different Member countries. Experience in some countries indicated that the availability of even two or three machines outside the computer laboratory significantly increased computer use across the curriculum. The Scottish HMI report had found that the most effective developments occurred where there was a written school policy and clear support for agreed developments from the administration, at least one staff member with computing expertise, and the specific allocation of co-ordinating arrangements to a senior staff member.

124. Technical assistance, trouble shooting and in-service support all need to be provided by an appropriately selected staff member who has been given a sufficient time allowance to handle these tasks.

125. The Seminar agreed that effective staff development and resource management in schools depends on the appointment of a computer co-ordinator, who should be allowed adequate time release from teaching duties to carry this role.

A Multi-Stage Approach

126. Professional development for the use of microcomputers in schools is likely to be problematic for at least three reasons. First, it is a technology which few teachers have had much exposure to in their earlier lives or in their experiences outside of school. Fear of the computer is still common. Second, it is a relatively complex technology compared to things like a video cassette recorder or a film projector. Without opportunities for sustained practice, the benefits of a short training course are quickly lost. Third, the history of microcomputer use in

schools is so short that we do not yet know where the agenda will stop. Already new topics and methods of teaching have emerged in schools where microcomputers are accepted and used. Ultimately teacher development in this area may be concerned with new models of the learning process itself.

127. Most of the countries represented at the Seminar described their professional development programmes in terms of a succession of stages. To overcome the initial fear of technology, public television programmes or Open University videotapes have been used, especially in the United Kingdom and in Canada. It has often been recommended that teachers be given a microcomputer to take home and practise with after a short course. In the Federal Republic of Germany there is a strong emphasis on self-teaching and distance learning, and teachers are given computers and software which is designed for self-teaching in relation to basic computing skills.

128. At the second stage, there is less emphasis on the technology itself, and more on software specification and evaluation, and on the development of complementary curriculum materials. Beyond this, what will happen in different Member countries will depend very much on whether or not the microcomputer is seen as a component of the educational reform movement, and what educational reform means in that context.

129. It was however, agreed, that given the complexity and potential range of the microcomputer as an innovation, a sustained programme is essential, and that effective development will require a configuration of activities including formal courses, informal workshops, self-teaching and mutual support, both within schools and between schools.

CONCLUDING COMMENTS

130. Through the wide range of application and systematic development programmes presented at the Seminar, it was evident that educational computing is now advancing beyond its earlier status as an uncertain innovation whose benefits were only evident in ad-hoc experimental fragments. These experiments have demonstrated the kinds of educational gains that are possible. To make these gains accessible across an education system it is necessary to arrange broad scale programmes for software dissemination and professional development. But at this stage the skills and understandings required for such professional development (as well as for further product development) are most likely to be found among practising teachers themselves.

131. A clear conclusion to be drawn from the Seminar is that achieving the potential benefits of educational computing will depend critically on recognising and rewarding these new teaching roles, through time release and other incentives, and creating new arrangements for involving teachers as partners in action research, software specification, curriculum change and professional development.

BIBLIOGRAPHY

Brophy, J. (1987) "Socialising Student Motivation to Learn". In M.L. Maehr and D. A. Kleiber (eds) Advances in Motivation and Achievement (Volume 5) (JAI Press, Grenwich, CT)

Center for the Social Organisation of Schools (1983) School Uses of Microcomputers: Reports from a National Survey (Baltimore, Md; Johns Hopkins University)

Commonwealth Schools Commission, Australia (1986) Computing History: Teaching With A New Technology (Videotape, CSC, Canberra)

Deakin Institute for Studies in Education (1987) Coming to Terms with Computers in Schools: Report to the Commonwealth Schools Commission (Deakin University, Australia)

Department of Education and Science (1987) Aspects of the Work of the Microelectronics Education Programme: Report by HM Inspectors for England & Wales

Dubuc, L. (1987) "Using Microcomputers in the Classroom: Some Generic Skills Required by Teachers" (paper presented at the SED-OECD Seminar on Microcomputers and Teacher Education, Glasgow 1987)

Entwistle, N. (1987) "Why Should Micros Make a Difference to Pedagogy?" (paper presented at the SED-OECD Seminar on Microcomputers and Teacher Education, Glasgow 1987)

Felder, D. (1987) Scolarisation de l'informatique à Genève, (Cahiers du Service de la Recherche Sociologique, no.22, Geneva)

Firkin, J; Davidson, M. & Johnson, L (1985) Computer Culture in the Classroom (Victorian Institute of Secondary Education, Melbourne)

Fitzgerald, D; Hattie, J. & Hughes, P. (1985) Computer Applications in Australian Classrooms (AGPS, Canberra)

France (1985) Ministère de l'Education Nationale, Inspection Générale: Note sur les Applications Pedagogiques de l'Informatique dans l'Enseignement Secondaire (15 June 1985)

Hawkins, J; Sheingold, K; Gearhart, M & Berger, C. (1982) "Microcomputers in Schools: Impact on the Social Life of Elementary Classrooms". Journal of Applied Developmental Psychology, vol. 3, pp 361-77

Hawkins, J. & Sheingold, K. (1986) "The Beginning of a Story: Computers and the Organization of Learning in Classrooms", in Culbertson, J. & Cunningham, L. Microcomputers in Education: 88th Yearbook of the National Society for the Study of Education vol. 1 (University of Chicago Press, Chicago)

Hunter, L. (1987) "Teaching an Old Dog New Tricks" (paper presented at the SED-OECD Seminar on Microcomputers and Teacher Education, Glasgow 1987)

Lesgold, A (1986) Information Techologies and Basic Learning: Main Issues and Future Prospects. General Report of the OECD/CERI International Conference on Information Technologies and Basic Learning (Paris, October 1986)

Nagtegaal, C. & Scholtes, P. (1987) Computers in Dutch Secondary Education (paper presented at the SED-OECD Seminar on Microcomputers and Teacher Education, Glasgow 1987)

Nisbet, J. & Shucksmith, J. (1986) Learning Strategies. (Routledge & Kegan Paul, London)

OECD-CERI (1987) Information Technologies and Basic Learning: Reading, Writing, Science and Mathematics. (Paris, the Organisation)

OECD-CERI (1987) Microcomputers and Secondary Teaching: Implications for Teacher Education (Appendix to Secretariat Report) Restricted. (Paris, the Organisation)

OECD-CERI (1986) Changing Work Patterns and The Role of Education and Training. Secretariat Report; Restricted. (Paris, the Organisation)

OECD-CERI (1985) New Teaching Functions and Implications for New Training Programmes: A Reader. Consultant Report; Restricted. (Paris, the Organisation)

OECD-CERI (1987) The Introduction of Computers in Schools: The Norwegian Experience, Examiners' Report. (Paris, the Organisation)

Papert, S. (1980) Mind-Storms: Children, Computers and Powerful ideas, (Basic Books, New York)

Schwartz, J. & Yerushalmy, M. (1985-1988) Geometric Supposer: Triangles; Geometric Supposer: Circles; Geometric Supposer: Quadrilaterals; Geometric Pre-Supposer (Sunburst Communications, Pleasantville, New York)

Scottish Education Department (1987) Learning and Teaching in Scottish Secondary Schools: The Use of Microcomputers. Report by HM Inspectors of Schools, (HMSO, Edinburgh)

Selmes, I. (1987) Improving Study Skills, (Hodder and Stoughton, London)

Weir, S. (1987) Cultivating Minds: A Logo Casebook (Harper & Row, New York)

Wills, S; Bunnett, A. & Downes. T. (1985) Convicts and Bushrangers: Educational Databases Brought Alive. In Oakley, J. (ed.) Computers in Education: Issues and Applications (NSW Computer Education Group, Sydney)

PAPERS AND MATERIALS DISTRIBUTED AND DEMONSTRATED

Papers Distributed During the Seminar

1. "Why Should Micros Make a Difference to Pedagogy?". Professor Noel Entwistle, University of Edinburgh (Paper presented)

2. "The Use of Microcomputers in Learning and Teaching in Scottish Secondary Schools". A Report by HM Inspectors of Schools, Edinburgh, HMSO 1987

3. "Inspectorate Study of the Use of Microcomputers in Scottish Secondary Schools". (overhead projector materials for presentation on Item 2) W T Beveridge HMCI, Scottish Education Department

4. Approaches in Teacher Training to Tackle the Pedagogical Implications of Introducing Microcomputers to the Secondary School Social Studies Classroom in Scotland: "Teaching an Old Dog New Tricks". L A Hunter HMI, Scottish Education Department (Paper presented)

5. Vocational Education Project: "Information Technology Across the Classroom. An INSET Strategy". Department of Education for Northern Ireland

6. "Computer in Dutch Secondary Education". C G J Nagtegaal/J P H Scholtes (paper distributed, and, separately copies of the overhead projector material).

7. "Teaching with Microcomputers: Enabling the Learning Experiences". J J McDonald HMI, Scottish Education Department (Paper presented)

8. "Microelectronics, Electronics, Computing and Information Technology Courses in Scotland 1987-1988". MEDC, Paisley, Scotland

9. "Experimental Activity with Computers in Norwegian Schools". Jan Wibe, Data Consultant, Ministerial Task Force, Norway.

10. "The Dutch NIVO Project - The New Computer Approach in Secondary Education".

11. CERI Project: Teacher Education, School Organisation and Educational Leadership - Country Summaries, OECD/CERI Paris, 9 October 1987 [This was an appendix to the background paper for the seminar "Microcomputers and Secondary Teaching: Implications for Teacher Education" prepared by OECD Secretariat in conjunction with the Scottish Education Department.]

12. Additional summary: Japan

13. Additional summary: Austria

14. Additional summary: Iceland

15. POCO: Plan of Action for Netherlands Project

16. "Information Technology and In-Service Teacher Education". John Gardner, Mary Megarity - School of Education, The Queens University, Belfast. ESRC Occasional Paper ITE/212/87. Distributed by University of Lancaster, England.

17. "Using Microcomputers in the Classroom: Some Generic Skills Required by Teachers". Dr Louise Dubuc, Canada. (Paper as presented)

18. Lothian Region TRIST packs "Computers as an Aid to Learning". (Notes of presentation)

19. Department of Trade and Industry Interactive Video in Schools Project.

Limited numbers were also available of the following papers: (contact national delegates for further details)

1. "Cours d'imitation a l'informatique dans les ecoles de matrite", Conference Suisse des Directeurs Cantonaux de l'Institution Publique CDIP, Bern, Switzerland 1987

2. "New Information Technologies and School - Informatics Instruction in Austrian Education".

3. "Information Technology in Northern Ireland Education", NICED Centre 1986, Stranmillis, Belfast BT9 5DY, Northern Ireland

The following documents were displayed: (contact national delegates for further details)

1. "Computers in Education: On the Crest of a Wave". Opening remarks at 4th Australian Computer Education Conference, August, 1986.

2. "Zen and the Art of Computing". Australia.

3. "Technology, Curriculum and Learning". Discussion paper for Education and Technology Task Force. South Australia, 1985.

4. "New Information Technologies in Education in Australia". Report for OECD, 1986.

5. "Computer Applications in Australian Classrooms". D Fitzgerald, J Hattie, P Hughes, 1986.

6. "Computers - Occupational Health and Safety". Australian Commonwealth Schools Commission, 1987.

7. "Will Mathematics Count: Computers in Mathmatics Education". Adrian Oldknow

8. There was no paper distributed by Karen Sheingold but copies of papers covering the topics referred to can be obtained direct from Miss Sheingold.

Videotapes Shown

1.	Denmark:	"Computers and how they work". (Contact Lise Dalgaard)
2.	Norway:	"Dadata 1 and Dadata 2". (Contact J Wibe)
3.	Netherlands:	"CAL in the Classroom". Begeleid door Marlies Smit, MEDION 1987, Delft. (Contact Cor Nagtegaal)

4. Australia: "Computing History"
"Fostering Enquiring Minds"
"Potential Unlimited - Computer technology for students with special educational needs"
(Contact Frank Mines)

5. United Kingdom: "Computers in the English Classroom". (Contact Ian Glen, Lothian Regional Council Education Authority, Scotland)
ZIGZAG "Computers in Schools". BBC Education. (Contact John Russell, BBC, Queen Street, Edinburgh)
Open University "Micros in the Classroom". 1984
"Investigating Science". 1986
"Information World". 1986 (Contact John Russell, BBC)

6. United States: "Inquire Project". Bank Street College
"Palenque Project". Bank Street College
Voyage of the Mimi - Holt, Reinhart and Winston
Episode I "The Feast"
Episode II "The New Alchemy"
"Mathematics, Science and Technology in the Elementary Classroom: A Beginning". The MASTTE Project. Bank Street College (Contact Karen Sheingold)

Demonstrations of Software and Materials

1. "Computer Assisted Topics". (Mrs P Watterson)

2. BBC Domesday and Ecodisc Projects. (Mr David Watkins, BBC TV Enterprises, London)

3. Software from SCET/SMDP

4. Software from Germany (Kompart, Dynamos) (Mr J Wederkind)

5. Software from the Netherlands (Free University, Amsterdam - Mathematics: Graph Functions) (Mr Cor Nagtegaal)

6. Interactive Video in Schools and for Teacher Education (Mr T van der Kuyl, Moray House College of Education, and Mr Ronning Rossvoll)

7. TRIST Staff Development Packs (Mr Ian Glen, Lothian Regional Council Education Committee, Edinburgh)

8. At BBC (software)

   a) "Introducing Geography", "River"
   b) "Technology and Design Course", "Pneumatics" (radio synchronised software) (John Russell, BBC, Edinburgh)

LIST OF PARTICIPANTS

Mr Frank Mines
Policy and Project Branch
Commonwealth Schools Commission
PO Box 34
Woden ACT 2606
Australia
Telephone Number: 6162 893643
Fax Number: 6162 893720

M Eduard Szirucsek
Ministere Federal de l'enseignement,
de l'Art et des Sports
1014 Vienna
Minoriten Platz No 5
Austria
Telephone Number: 43 222 53120 4335

M Anton Reiter
Ministere Federal de l'enseignement,
de l'Art et des Sports
1014 Vienna
Minoriten Platz No 5
Austria
Telephone Number: 43 222 53120 3523

M Laumen
Inspecteur de l'enseignement secondaire
et superieur
Zeearendstraat, 24
B-2100 Deurne
Belgium
Telephone Number: 03 3251780

Mr B R Haines
Chief Director
Public Education Program
PO Box 578
Halifax
Nova Scotia B3J 259
Canada
Telephone Number: 902 424 5799

Mme Louise Dubuc
Co-ordonnatrice de l'evaluation des logiciels
Direction des Resources Didactiques
Ministere de l'Education du Quebec
600 Fullum, 3e etage
Montreal
Quebec
Canada H2K 4LI
Telephone Number: 514 873 2678

Mr Martin Lund
HMI (Advisor)
Directorate of Upper Secondary Education
Amagertorv 14
DK-1160 Copenhagen K

Mr Martin Lund
Private:
Mensalgardveg 36
DK-5260 Odense
Denmark
Telephone Number: 9153396

Ms Lise Dalgaard
HMI (Advisor)
Directorate of Primary and Lower Secondary
Education
Frederiksholms Kanal 26
1200 Copenhagen
Denmark
Telephone Number: 01 925 300/01 925 316

M Andre Lafond
Inspector Generale
President de la Commission Informatique
de l'Inspection General de l'Education Nationale
74 Rue Dunois
75013 Paris
France
Telephone Number: 1 45 85 01 01
Email Number: By Minitel: (1)36-
13*EDUTEL*LAFO

Mr Manfred Kremer
Assistant Head of Division
Federal Ministry of Education and Science
Heinemannstrasse, 2
D-5300 Bonn
West Germany
Telephone Number: 49228 572182

Dr Karl-August Keil
Director
Zentralstelle fur Programmierten Unterricht
und Computer im Unterricht
Schertlinstrasse 7
D-8900 Augsburg
West Germany
Telephone Number 0821 571779

Dr Joachim Wedekind
Project Leader
Deutsches Institute fur Fernstudien
Woehrdstrasse, 8
7400 Tuebingen
West Germany
Telephone Number: 07071 33407

Mr Yngvi Petursson
Lecturer
Icelandic Institution of Education
V/Stakkahlid
105 - Reykjavik
Iceland
Telephone Number: 91 688700

Dr Brendan O'Regan
Schools Inspector
St Martha
Clan Morris Avenue
Limerick
Ireland
Telephone Number: 061 54858

Mme Marta De Vita
Inspecteur
Direction Regionale de l'Enseignement de Milan
Via Vallisneri, 13(b)
20133 Milano
Italy
Telephone Number: 02 2367341/02 873251

Mr Hidetsugu Horiguchi
Section of Educational Software Development
Center for Educational Resources
National Institute for Educational Research
6-5-22 Shimomeguro
Meguro-Ku
Tokyo 153
Japan
Telephone Number: 03 714 0111

Dr Unna Huh
British Society Scholar
Darwin College
Cambridge
CB3 9EU
England
Telephone Number: 0223 335660 extn 5691

Also
Department of Educational Technology
Han Yang University
17 Sungdonggo, Hangdangdong
Seoul
Korea
Telephone Number: (292) 3111 extn 3941

Mr John Scnoltes
Advisor, Information Technology
National Catholic School Board
Katholiek Pedagogisch Centrum
Postbus 702
5201 AL's Hertogenbosch
The Netherlands
Telephone Number: 073 215435

Mr Cor G J Nagtegaal
Project Manager, In-Service Training
NIVO-Project
Lomanlaan 83
3526 XC Utrecht
The Netherlands
Telephone Number: 31 30 892374

Mr Jan Wibe
Edb-consultant
Ministerial Task Force for the
Introduction of Computers in Schools
Datasekretariatet
postboks 8183 Dep
0034 Oslo 1
Norway
Telephone Number: 07 916692 (private)
Telephone Number: 02 119121 (office)

Ms Mette Ramberg
Senior Executive Officer
Ministerial Task Force for the
Introduction of Computers in Schools
Datasekretariatet
Postboks 8183 Dep
0034 Oslo 1
Norway
Telephone Number: 02 246996 (private)
Telephone Number: 02 119123 (office)

Mr Harald Haugen
Head of Computer Science Department
Stord College of Education
N-5414 Rommetveit
Norway
Telephone Number: 54 10288

Professor Antonio Dias de Figueiredo
Faculdade de Ciencias e Technologia
Universidade de Coimbra
3000 Coimbra
Portugal
Telephone Number: 039 724275
Telecom Gold Number: 81:CET037

Mr Arne Lindquist
Senior Lecturer
Uppsala University
Box 2136
75002 Uppsala
Sweden
Telephone Number: 018 182465

Mr Christian Jung
President des Ausschusses fur Informatik
der PK-EDK
Oberfeldstrasse 1
8500 Frauenfeld
Switzerland
Telephone Number: 054 21 75 39
Email Number: Com Net: TG JUNG

Dr Karen Sheingold
Director
Center for Children and Technology
Bank Street College of Education
610 West 112th Street
New York
New York 10025
USA
Telephone Number (212) 663 7200

Mr Zvonko Danjanovic
Center for Multidisciplinary Studies
Slobodana Peneztca 35/III
Beograd (Belgrade)
Yugoslavia
Telephone Number: (11) 340 545 (private)

Mr Pierre Duguet
Principal Administrator
Head of Project on Education and Technologies
OECD
2 Rue Andre Pascal
75775 Paris
France
Telephone Number: (1) 45 24 92 36
Email Number: CERI AT FRMOPII
(EARN/BITNET)

Ms Margaret Vickers
Administrator
OECD
2 Rue Andre Pascal
75775 Paris
France
Telephone Number: (1) 45 24 92 36
Email Number: CERI AT FRMOPII
(EARN/BITNET)

Mr John Foster
Director
Microelectronics Education Support Unit
Sir William Lyons Road
Science Park
University of Warwick
Coventry CV4 7EZ
England
Telephone Number: 0203 416994
Email Number: 84:MEP529

Mr E H Leaton HMI
Department of Education
(43 Park Hill Road
Sidcup
Kent DA15 7NJ)
England
Telephone Number: 01 300 1211
Email Number: YNB029

Mr John J McDonald HMI
Scottish Education Department
Roon 3.30
New St Andrew's House
Edinburgh EH1 3SY
Scotland
Telephone Number: 031 244 4531/4154
Email Number: TTNS 01:YLI011
Fax: 031 244 4786/4787

Mr Alistair Fyfe
Assistant Director
Scottish Council for Educational Technology
74 Victoria Crescent Road
Glasgow G12 9JN
Scotland
Telephone Number: 041 357 0340
Email Number: TTNS 01:YLI004
Fax: 041 334 6519

Mr Martyn Roebuck HMI
Scottish Education Department
Room 3.22
New St Andrews House
Edinburgh EH1 3SY
Telephone Number: 031 244 4565/4154
Email Number: 74:MIK1547
Fax 031 244 4786/4787

Mr Alistair Campbell
Assistant Principal
Northern College of Education
Hilton Place
Aberdeen AB9 1FA
Scotland
Telephone Number: 0224 482341

Mr David Gibson
Co-ordinator of Learning Resources
St Andrew's College of Education
Bearsden
Glasgow G61 4QA
Scotland
Telephone Number: 041 943 1424

Mrs Patricia Watterson
Jordanhill College of Education
Southbrae Drive
Glasgow G13 1PP
Scotland
Telephone Number: 041 959 1232
Email Number: 01:YTZ010 or 72:MAG11815

Professor R Lewis
Department of Psychology
University of Lancaster
Lancaster LA1 4YF
England
Telephone Number: 0524 65201 extn 4547
Enail Number: Dialcom 10001:YMA027
JANET PSG001@LANCS.VAX1

Adrian Oldknow
West Sussex Institute of Higher Education
"The Dome"
Upper Bognor Road
Bognor Regis
West Sussex PO2 1HR
England
Telephone Number: 0243 865581

Mr Tom Smith
Advisor in Computer Education
Tayside Regional Council
Tayside House
28 Crichton Street
Dundee DD1 3RS
Scotland
Telephone Number: 0382 76518

Mr Ronning Rossvoll
Belmont Teacher's Resource Centre
Belmont Street
Aberdeen
Scotland
Telephone Number: 0224 646612

Mr Norman Morrison
Department of Education Northern Ireland
Rathgael House
Balloo Road
Bangor
County Down DT19 2PR
Northern Ireland
Telephone Number: 0247 466311