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AUTHOR Lipkin, John
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ABSTRACT

Future issues for equity in education are discussed in this paper. It is argued that computer literacy is increasingly becoming a key element in a child's education and future success. A growing body of evidence is cited which shows that access to microcomputers in the schools will be more limited for poor and minority students than for wealthier, majority students. It is also hypothesized that female students may not participate in advanced programs for mathematics, science, and related activities to the degree that male students will participate. Further data cited indicate that more computers are being purchased and made available by wealthier districts, and that more sophisticated student-computer interaction takes place within these districts. The paper concludes with a review of the potential assistance that Federal and State governments can provide to help achieve equity in this new field. (Author/GC)

EQUITY AND MICROCOMPUTER USE IN
AMERICAN PUBLIC EDUCATION

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LEC-83-15

by
John Lipkin

Education Commission of the States
1860 Lincoln Street, Suite 300
Denver, Colorado 80295

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ABSTRACT

The future issues for equity in education are discussed in this paper. This paper makes a case for computer literacy as a key element in a child's education and future success. The author cites a growing body of evidence that access to microcomputers in the schools will be different for poor and minority children than for wealthier, majority children. He also cites evidence that female students may not participate in advanced programs for math, science and related activities. He finds the trend is for more computers in wealthier districts, and for more sophisticated interaction between computer and child in these districts. Finally, he reviews the potential assistance state and federal goverments can provide to help achieve equity in education in this new field.

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THE ADVENT OF MICROCOMPUTERS

The Significance of Computer Literacy

This paper outlines the likely impact of the telecommunications revolution on education. In particular, it explores the implications for traditional concerns of equity as public schools rapidly acquire microcomputers.

Underlying our inquiry is the premise suggested by Daniel Bell:

> A new social framework based on telecommunications is replacing a social framework based on industrial production, and it is the computer which holds the key to the conduct of social and economic exchange, the character of occupations and work and the way in which knowledge is created and retrieved./1\

Alan Kay, now the chief scientist for Atari, a leading manufacturer of personal computers, was among the first to recognize the importance of computer literacy on a widespread scale. In a seminal 1977 article in *Scientific American*, he suggested that the significance of computing could be compared to that of writing. Three broad levels of skills are possible in either medium -- illiteracy, literacy and artistic creation. Kay argued that the changes brought about by computer literacy would be as far-reaching as those brought about by reading and writing. Thus, he has suggested the desirability of universal computer literacy./2\

If the perceptions above are correct, then, to perform its fundamental task of preparing youth for participation in adult society, the education system of this country must teach students to communicate with and through the computer.

The value of computer literacy in an information society can be thought of in terms of its relationship with human productivity and learning. Knowledge of the computer is becoming closely linked to employment prospects, and many, if not most, jobs in the future will require some computer knowledge and skill. At the same time, the computer is becoming an educational tool that aids learning and develops intellectual capacities.

From a national perspective, computer literacy is coming to be viewed as a desideratum for maintaining a superior economic and military position in a competitive and threatening world. This, it is felt, can be accomplished only if students emerging from the educational system are capable of reflective thinking and decisive action based on knowledge in many areas, but especially in science, mathematics and technology.

It is interesting to speculate about whether the emphasis in the public school curriculum on developing the problem-solving capacities of students is a response to the computer, or the computer is a response to the demand for greater problem-solving capacity. In any event, the computer provides educators with a means for developing the intellectual capacity of all students. As David Moursund, a noted computer educator has explained, the procedural thinking inherent in computer use develops and exercises a number of intellectual skills. Intelligent computer use involves "following written instructions, observing and explaining steps of a process, sequencing events in chronological and spatial order, logical thinking, the use of a foreign language and problem-solving."/3\

As this introduction is intended to illustrate, many different hopes are pinned on the computer. One of the more optimistic and far-reaching is that the computer will mitigate the age-old distinction between thinkers and doers by providing us all with the means to be both.

Educational Uses of the Microcomputer

Ways the Computer Can Be Used

A consideration of the ways the computer is used in public schools illustrates its potential benefits and shows the applicability of computer use for all students./4\

(1) Computer-Assisted Instruction (CAI): There are two types, tutorial programs and drill and practice. The latter is commonly criticized as a "flash-card" or "work-book" approach, because it is limited to a stimulus-response type of instruction and does not use the capacity of the computer to a great extent. Drill and practice defenders note that preliminary skills learned by this method are necessary for functioning at

higher cognitive levels and that the computer offers an effective means to provide this type of instruction.

(2) Programmed Learning Approach: The subject matter is organized into instructional sequences. The programs typically stress active responses and make extensive use of feedback and branching to previous material or alternative sequences when students are not mastering specific objectives.

(3) Simulation Programs: Some elements of programmed learning are typically included, but the central element of the program is some simulation, usually of an environmental event. Examples include chemistry experiments, the 19th century westward movement of American pioneers, or the prediction of a volcanic eruption.

(4) Systems Based on Artificial Intelligence: The program simulates the action of an expert human tutor based on rules or heuristics identified through observing or interviewing an expert. For example, based on a knowledge of how different pupils perform in different curriculum areas, the computer will make "intelligent" decisions about which materials to present and the probability of further productive testing in a particular knowledge sequence.

(5) Computer Managed Instruction (CMI): This form of microcomputer use emphasizes the management of instruction-related information rather than the direct teaching of pupils. Information about testing, diagnosis, learning prescriptions and record keeping is included in CMI. The benefits gained when instruction is controlled by computer can be illustrated by the GEMS Project (Goal-based Educational Management System). GEMS provided the essential research base and monitored the work of 20,000 students in a Salt Lake City school district. As a result of GEMS, the average reading comprehension score rose 10 points from 45 to 55, and the average vocabulary score jumped 21 points from 45 to 66. One of the impressive findings in the data was that all populations -- high-performing students, Title I students (economically disadvantaged), and students with learning problems -- benefited. Alan Hofmeister, of Utah State University, stresses that the computer itself did not bring about the improvement. Rather, it was a tool used with skill and sensitivity by school staff to significantly improve the achievement of thousands of pupils.

Components of Computer Literacy

Two major components of computer literacy are: (1) computer use -- mastery of technical skills necessary to interact with computers and (2) computer awareness development of understanding and attitudes needed to function effectively in a computerized society.

Central to computer literacy is the ability to access and apply information stored in computers. Moving information between the individual and the computer requires structuring that information in a form acceptable to the computer. Representing the information as an algorithm is the gateway skill for computer programming. Individuals who do not understand algorithmic structures are forced to react rather than interact, usually at the mercy of the software.

As the foregoing summary suggests, the computer can provide beneficial learning experiences in a wide variety of ways to a broad range of students. In fact, the computer has been found to be an effective aid to learning for virtually all ages and ability levels. Even pre-schoolers are being taught reading and mathematical readiness skills with microcomputers,/5\ and elementary school students can learn the elements of programming and a systematic approach to problem-solving. Following the lead of Seymour Papert, and in many instances using the LOGO software he developed, young children are learning basic reading and mathematics concepts as they learn the fundamental principles of computer programming./6\

The universality of Papert's approach, which in effect combines CAI and computer literacy, has yet to be demonstrated. Nonetheless, it provides a concrete basis for hope that all students can be initiated into the mysteries of the computer and led to the point where they can use it as a problem-solving tool.

The Growth of Microcomputer Use in the Schools

Recognizing the computer's import and benefits, a growing number of the nation's elementary and secondary schools have adopted computers as management tools and use the computer not only to enhance learning (CAI) but also as an object of learning in its own right (computer literacy).

Since the microcomputer began coming into the schools in substantial numbers in 1979, it has gained the widespread endorsement of school and government officials, teachers, students and parents. The microcomputer is now commonly recognized as a major educational force rather than the fad that skeptics, at least until recently, claimed it might be. Reports from a national survey conducted during the 1982-1983 school year indicate that 53% of the nation's public schools now use micro-computers for instructional purposes. By January 1983, 85% of all high schools, 77% of all junior-senior high schools, 6C% of all middle and junior high schools and 42% of all elementary schools were using microcomputers. Furthermore, the rate of growth of microcomputer use had increased during the latter half of 19C2./7\

The extensive use of microcomputers and the rapid rate at which use is increasing might lead to the conclusion that they will soon be available for all students. Unfortunately, such a prognosis is not warranted. It should be borne in mind that only a small proportion of the students in schools with microcomputers actually participate in microcomputer instruction./8\ Available evidence indicates that, under present circumstances, many schools cannot afford enough microcomputers to provide an effective program for all of their students.

EQUITY AND INEQUITY IN MICROCOMPUTER USE

Is Equity an Issue?

Assumptions

Our view of the problem of equity in computer-based education is predicated upon a number of assumptions -- assumptions of values as well as of facts:

- The microcomputer is a valuable and scarce resource.
- School systems throughout the United States are endeavoring to use microcomputers in conjunction with a sound educational program.
- Students who participate in effective computer-based education programs will have distinct learning advantages and enhanced opportunities for further education and economically rewarding job opportunities.
- There is no inherent reason why the benefits of computer learning should not be extended to all students.
- A democratic society has an obligation to provide every citizen with full and equal educational opportunity.

Defining Equity in Microcomputer Education

Understanding how the principle of equity can and should be applied to microcomputer use in public education demands a common understanding of the term "equity." Brookover and Lezotte provide a useful starting point by suggesting three criteria for determining equity: (1) (the access standard) Do all students have equal access to facilities and services? (2) (the participation standard) Do practices or programs guarantee equal participation to all? (3) (the benefits standard) Are the intended benefits spread among the entire population of users in a non-discriminatory manner?/9\ Based on these criteria, equity of microcomputer use in public education could be said to exist when all students have the opportunity to benefit from instruction according to their personal capacity regardless of race, color, religion, sex, age, handicap, national origin or social class.

In determining the extent to which reality deviates from the ideal expressed in the definition, the operational question is: Who receives what form of computer-based education under what circumstances, with what results or benefits? This question, it can be noted, includes a consideration of the three equity criteria: access, participation and benefits.

The Justification for Equity

Raising the question of equity is justified when the prevailing pattern of microcomputer use and the propensity of the educational system to reinforce class divisions are considered. In a report sponsored by the Club of Rome, Klaus Lenk noted that "the most outstanding implication of the new information technology is that it is utilized first by those who can afford it." Lenk believes that the "Matthew Effect" -- "For whosoever hath, to him shall be given" -- operates in the use and spread of technology. This suggests that the wealthy and the powerful are the first to take up new technologies, which they then use to their own advantage and the disadvantage of others./10\

One of the first persons to identify the tie between microcomputer use and equity in education was J.M. Nilles./11\ He foresaw that personal computers were likely to be adopted by schools and individuals in affluent rather than low-income areas, unless public policy compensated for the difference in purchasing power. Nilles' prescient warning could serve as the major hypothesis for this general discussion:

> If personal computers fulfill their potential to make learning more effective and to increase learning, the learners in the more advantaged strata will increase the education gap between themselves and those who do not have access to the personal computer. Higher income learners will become more competent learners and, to the extent that this increases productivity, their income differences will increase./12\

Early evidence that Lenk's observation (the rich utilize new technologies first) applies to microcomputers was presented by Victor Walling. According to his account, the middle class began to demonstrate an appreciation of the educational benefits of the microcomputer when it was first introduced in the mid-1970's. Walling predicted that middle-class parents with microcomputers would see no further need for schools./13\ What Walling and many other observers failed to foresee, however, was the mutual adaptability of the school and the microcomputer.

Inequities in Microcomputer Practices

A review of what is known about equity in computer use in public education has revealed little systematic inquiry and data collection. Therefore, we have had to utilize secondary analysis of data, and evidence of a fragmentary or observational nature.

The first extensive survey of microcomputer use in public education was undertaken by Market Data Retrieval (MDR) in 1981. This telephone survey of all of the nation's public schools revealed that 30% of the wealthy school districts used at least one microcomputer for instructional purposes. The corresponding figure for the poorest school districts was 12%. Wealthy school districts were defined as those where less than 5% of the population was below the poverty level./14\ This uneven penetration of computers into schools persisted the following year. A follow-up survey conducted by MDR indicated that 80% of the 2,000 largest, richest high schools owned instructional computers, while only 40% of the smallest, poorest high schools had them. A similar pattern was observed in elementary schools./15\ Furthermore, this disparity is likely to remain for the foreseeable future since schools that already have microcomputers are more likely to buy additional ones than schools without microcomputers are to make initial purchases./16\

It is reasonable to infer from the MDR data that minority groups, specifically Blacks and Hispanics, have less access to computers than their English-speaking, White counterparts, since minorities are preponderant in poorer school districts. This inference is confirmed by early reports from a 1982 survey under the auspices of the National Science Foundation, that found computers were used in 32% of the "urban, rich" schools but in only 18% of the "ghetto" schools./17\

The handicapped also lack access to computer-based education. According to a study by Melinda Lindsey, this is due in part to the lack of appropriate software, because of the relatively small population of handicapped students./18\ Software developers tend to concentrate their efforts in areas that provide the greatest profit. This simple economic fact may also help to explain the paucity of software for non-English speaking students./19\

Geographical setting also correlates with access to microcomputers. Rural areas, particularly those at a great distance from technological centers, fall considerably behind non-rural areas in computer acquisition./20\ Also, there is variation from region to region of the United States, with the Southeast lagging behind other regions./21\

There is also reason to believe that males realize greater benefits from the microcomputer than females. Data from the California State Department of Education and a survey of secondary schools in Michigan undertaken by PEER (Project on Equal Education Rights, a project of the NOW Legal Defense and Education Fund) reveal that male enrollment in secondary-level courses on the fundamentals of computer programming outstrips female enrollment by nearly a two to one margin./22\

Although the participation rates of females and minority students approximate the overall participation rate of majority males in computer-based education, there appears to be a difference in the kind of instruction received -- and, hence, in the benefits of instruction. Daniel Watt, former computer scientist at the Massachusetts Institute of Technology, and currently an editor of BYTE magazine, has observed that computers are generally used in suburban schools for programming and awareness courses (computer instruction or computer literacy). In less affluent, rural or inner-city schools, children are more likely to be restricted to computer-assisted instruction -- drill and practice. Thus, he notes, affluent students are learning to tell the computer what to do, while less affluent students are learning to let the computer tell them what to do./23\

There is a reasonable explanation for the relatively high incidence of minority students in CAI courses: these students are more likely to be lower-income, and thus, educationally disadvantaged. Thus, they are more likely to require drill-and-practice remedial instruction in mathematics and English language skills. The use of the microcomputer for drill and practice to master specific knowledge or skills is a demonstrably effective educational practice./24\ It does not follow, however, that CAI is a substitute for computer literacy courses or that minorities or females should be underrepresented in those courses. The ideal is that all students be provided with the instruction that will enable them to use the computer as a problem-solving tool.

The pattern of inequity in microcomputer use emerging from available evidence could be summarized as follows.

- o Wealthy school districts are the first to purchase microcomputers and to develop extensive courses in computer use.
- o The use of the microcomputer in inner-city and rural schools is likely to be restricted to drill and practice exercises that do not sufficiently develop the capacity to use or understand this valuable tool for learning.
- o Disadvantaged students and members of minority groups -- Blacks and Hispanics in particular, by virtue of their lower socio-economic status -- are less likely to receive computer education than middle class white students.
- o Students from certain regions of the United States, notably the Southeast and from rural areas remote from centers of technology, have less access to microcomputers than students elsewhere.
- o Access to computer instruction for handicapped students is limited.
- o Fewer female students than male students are participants in computer education courses that lead to a mastery of the computer.
- o Educational software or courseware does not adequately reflect the backgrounds, interests or language differences of minority group members.

The Microcomputer as an Equalizer

Paradoxically, the microcomputer could be a force for greater equity in public education and the society at large. As Christopher Dede has noted, "If equal access to high quality instructional technologies designed to meet the needs of diverse groups were guaranteed, educational discrimination and inequality in society might be reduced."/25\

The case of education for the handicapped illustrates Dede's point that computers can serve as equalizers for special populations. As Robert B. Herman, formerly Associate Deputy of Health, Education and Welfare, explained to the U.S. Congress, the computer can be used to compensate for handicaps. For example, computer-generated speech is used by persons with limited speaking ability; the computer could also educate handicapped children in the context of regular school programs. As Herman explained, "The computer can be the patient, non-threatening instructor that can repeat over and over again for a child with a learning problem, and it also can provide a child who is limited in his (or her) expressive abilities new ways to express his (or her) ideas and thoughts."/26\

The very obstacles that keep the disadvantaged from gaining an understanding of the computer can be overcome by using the computer. The disadvantaged, defined by Childers as those who lack something the society considers important,/27\ may have a low level of information processing skills; the computer can serve as the instrument for the development of such skills. The disadvantaged often lack contact outside their own subculture; the computer can provide two-way communications with the outside world. The disadvantaged are likely to have an unfavorable disposition toward learning; the computer can provide positive reinforcement and, hence, motivation.

By way of summary, the prediction that the microcomputer would be used first to benefit students from affluent families is proving to be true. Since the microcomputer can improve learning, and computer literacy results in enhanced educational and, ultimately, economic benefits, the schism between the rich and the poor is likely to widen if access to computer instruction is not equitable. The computer has the potential to benefit all students, but the means for establishing equitable use of computers in the public schools have yet to be established.

The patterns of computer use reflect well-documented inequities in American public education. The findings presented here are not new, but their likely social consequences are startling. If developments of educational technology in general and microcomputers in particular continue to follow their natural course, the gap between the "haves" and the "have nots" could widen to a socially intolerable point.

POLICY CONSIDERATIONS

The essential point of view taken in this inquiry is that the evolution of microcomputer use in the public schools (and the society at large) is adhering to a course which seems to reinforce the advantages of birth and circumstances enjoyed by some over others. Considerations of social justice, national well-being and pedagogy all suggest that this course, however predictable or inevitable, should be altered in order to assure greater equity. Equity in microcomputer education can be said to exist when all students, regardless of background or circumstances, achieve a level of computer literacy commensurate with their interests, needs and capacities. The determination of appropriate policy and the translation of policy into practice are major challenges confronting the American educational system today.

The Federal Government and Educational Technology

The federal government has not only a right but a necessary obligation to participate in a national quest for equity in the educational use of computers. The legal sanction for the federal government to address inequities in microcomputer education is found in the equal protection clause of the 14th amendment of the Constitution. In the final analysis, only the federal government can redress the disparities in educational opportunity that result from variations in state wealth. At the same time, education has always been primarily a state, local and private concern, and there is considerable support for the view that it should remain so./28\

In keeping with this point of view, the current Republican administration under President Reagan has taken a decidedly restrictive view of the federal government's participation in education. Thus, believing that reducing the federal presence can improve the economy and public education, the administration sponsored the Education Consolidation and Improvement Act of 1981 (ECIA).

ECIA provided a two-part block grant to replace most federal programs in elementary and secondary education. Chapter I of ECIA, like its predecessor (Title 1 of the Elementary and Secondary Education Act), has a redistributive feature that provides a higher proportion of funds to socio-economically disadvantaged students. Chapter 2 consolidated 29 categorical programs into a single block grant "to be used in accordance with the needs and priorities of state and local educational agencies as determined by such agencies."/29\

A review of the pattern of utilization of Chapter 2 funds in selected states concluded that "large amounts are being spent for computer related purchases." It was further observed that computer expenditures often related to a high priority already identified by the school district, the state education agency and the state government./30\

It would appear that ECIA is having a positive effect on equity in mincocomputer use. Federal funds are permitting purchases of microcomputers by districts that otherwise could not afford them and, to the extent that the federal government's redistributive intentions are being carried out, poorer districts and schools are being given extra assistance. However, overall federal support -- estimated to be about 8% of total educational expenditures/31\ -- is not sufficient to provide comprehensive computer education programs for disadvantaged elementary and secondary school children. Nor is it sufficient to equalize the capacities of rich and poor school districts to provide such programs.

To date, federal efforts to promote technology in education have been more symbolic than real. By sponsoring research and supporting local efforts, the Department of Education and the National Science Foundation have served as what euphemistically has been termed "cheerleaders" or "unobtrusive catalysts."

Unlike the Department of Education, the National Science Foundation has recognized the problem of equity. In fact, two Foundation spokespersons, Dorothy Deringer and Andrew Molnar, have called for policies to produce greater equity./32\ Moreover, a forthcoming NSF-sponsored report, <u>Educating Americans for the 21st</u>

Century, has recommended measures which address the issue of equity. One of its key recommendations is that "programs are needed in mathematics, science and technology that reach all students and stimulate each to achieve an understanding of these subjects that is limited only by his or her talent and temperament. The unique national role of the federal government . . . in ensuring access in its broadest sense to educational opportunity must contine."/33\ The Department of Education, by contrast, has not called attention to equity-related problems in educational technology.

Congress appears to be more inclined to pursue an active approach than the federal agencies. The House of Representatives passed the "Emergency Mathematics and Science Education" bill with overwhelming bipartisan support (348 to 54). This act would provide $425 million in new program authorizations for the Department of Education and the National Science Foundation in mathematics, science and technology. In the Senate, counterpart legislation, the "Education for Economic Security Act," has been passed by appropriate committees and is expected to come to the floor of the full Senate in 1984./34\

Another piece of proposed legislation of particular relevance to considerations of equity in microcomputer education is "The Computer Literacy Act of 1983." This legislation sponsored by Colorado Democrat Timothy Wirth, would allocate $300 million per year for the next ten years to help local education agencies acquire computer hardware. Schools with the least hardware would be the first to receive local funds, and funds are not to be provided to any school after it has the equivalent of one unit of computer hardware for each thirty students./35\

In spite of pending legislation and a growing awareness of the equity problem, the prospects for passage of federal legislation that would allocate funds on the scale required to make a substantial contribution to the establishment of equity in computer education do not appear bright at this time. The ambiguity of the federal role in education, political differences over what the role should be, and a weak, debt-ridden economy combine to make federal direction and support highly uncertain, regardless of how necessary it may appear to be.

The State Role

The State Potential

During the past two decades, the states have assumed increasing responsibility for equity in education. Evidence of this can be seen in the greater proportion of expenditures met by states in reforms of state-aid formulas to bring about greater equity, and in the establishment of compensatory education programs, bilingual programs and competency testing programs./36\

Numerous reasons for the increase in state activity can be cited, including the stimulus provided by the federal government, the increase in school expenditures which local districts have been unable to meet and a growing demand for accountability. In addition to providing an increased proportion of funds, many states have established a significant educational leadership role in such vital areas as planning, evaluation and services to local districts./37\

Since the advent of the microcomputer, educational activities at the state level have been particularly evident. Increasingly, states have come to the view that technology is required for economic development, and that the basis for attracting and developing technology is an appropriately trained and educated workforce. In an effort to create favorable conditions for technology's advance, many states are establishing and implementing extensive statewide plans for computer use in education. It is a fortunate coincidence that the states are poised to provide leadership at the same time that it is needed for the establishment of high quality, equitable computer education programs.

William Wilken, who provides technical assistance in microcomputer education to several states, has identified three vital areas of state activity in computer education:

1) The statewide purchase, development and production of material, which can bring considerable savings.
2) The provision of technical assistance to schools at the state level or intermediate level (education service agency) in such areas as staff development and purchase of supplies and equipment.
3) The identification and development of policy addressing issues that arise in microcomputer education, not the least significant of which is likely to be the issue of equity./38\

Some State Initiatives

The following illustrations from a survey undertaken by Education Week present a more concrete idea of the computer-related activities being undertaken by the states. They have been selected to suggest the range of state activities, particularly as these activities relate to equity.

Arkansas. A state task force has developed recommendations on computer literacy for distribution to school districts, colleges, universities, and professional groups such as the state's association of mathematics teachers. Arkansas State University and other institutions of higher education are planning to introduce a computer literacy requirement for graduation from its teacher training program.

California. Fifteen "high-tech" training centers located near state universities offer in-service training for teachers in computer literacy, mathematics and science. Each center provides one- or two-day workshops to hundreds of teachers, at a cost of $9 million per year.

Minnesota. The Educational Technology Act (1983) has been funded at $5.8 million per biennium. This act provides funds for in-service training in the use of educational technology, for the establishment of demonstration sites and the development and evaluation of educational software. Most of the efforts are to be directed toward promoting computer literacy, programming and applications rather than toward computer-assisted instruction. The Minnesota Educational Computing Consortium (MECC), a leading agency nationwide in the development of educational technology, underwent some structural changes during the 1983 legislative session. Once a full-fledged state agency, MECC is now a "quasi-public" agency and has been freed from certain state government restrictions on salaries and hiring policies. It develops software, which it sells at cost to Minnesota and other dues-paying members and at a profit to other schools. It also acts as a broker for several computer firms, supplying hardware to schools at below-market prices.

Florida. In June of 1983, Florida passed the "Educational Reform Act of 1983". This act

1) establishes minimum performance standards for students in mathematics, science and computer courses,

2) authorizes new programs of excellence in mathematics, science and computer instruction and summer educational camps for public school children,

3) orders the State Commission of Education to develop a comprehensive plan for the improvement of instruction in mathematics, science and computer instruction.

Montana. Montana is reportedly becoming a national leader in computer education in public schools. An estimated 96% of elementary and secondary school students have access to computers. The statewide ratio of computers to students is 1 to 84 and the goal is 1 to 60 in the next year or two. Grants from the National Science Foundation in 1981 allowed the state to train 20 regional computer consultants who now run in-service training programs for the districts. They have conducted 20 regional computer conferences over a two-year period. Also, a traveling computer library and training program move from district to district. State law provides a 30% writeoff to individuals or corporations who give computers manufactured after 1978 to the schools./39\

As the above illustrations indicate, the individual states are taking the lead in promoting computer education within their respective jurisdictions. A common denominator of the various state efforts is that they are designed to bring more effective computer education to more students.

To the extent that state level activities promote the establishment of more widespread and more effective computer education programs, the ideal of equity is being served. The contribution of state level policies to greater equity in computer education is dependent upon two major factors: the size of the state contribution and the degree to which this contribution is compensatory or redistributes the computer's benefits from the rich to the poor. Given the limitations on state resources and their variation from state to state, there are naturally limits to the extent of equity which can be achieved under state auspices.

The magnitude and the scope of the task of establishing an educational system which will result in producing a generation of computer literate students goes beyond what can be accomplished by the individual states alone. This task will require a concerted national effort which combines the resources and commitment of all levels of government and a corresponding contribution from the private sector. A more cooperative and harmonious relationship among all levels of government and between govenment and its constituents is naturally considered to be a desirable goal. The exigencies of the technological era may render the attainment of this goal a necessity.

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