DOCUMENT RESUME

ED 248 831 IR 011 280

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TITLE	Microcomputers in Education: An Introduction.
INSTITUTION	Northeast Regional Exchange, Inc., Chelmsford, MA.; Technical Education Research Center, Cambridge, Mass.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
PUB DATE	Jan 82
GRANT	NIE-G-81-0034
NOTE	86p.
AVAILABLE FROM	Northeast Regional Exchange, Inc., 34 Littleton Road, Chelmsford, MA 01824 ($6.00 per copy; $5.00 per copy for 10 or more).
PUB TYPE	Guides - Non-Classroom Use (055) -- Tests/Evaluation Instruments (160)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Computer Oriented Programs; Computer Software; *Decision Making; *Information Sources; *Microcomputers; Models; *Program Development; Program Evaluation; *Program Implementation; Staff Development
IDENTIFIERS	Computer Uses in Education; New York; Software Evaluation; Software Reviews

ABSTRACT

This general introduction to educational uses of microcomputers provides basic information to assist educators, parents, and concerned citizens in implementing microcomputer programs in the schools. An overview and brief history of educational computing is followed by suggestions which emphasize the need for planning, including pitfalls to avoid, establishing a planning group, and funding strategies. A range of state policies, practices, and services are described. Computer applications are listed and categorized as using the computer either as teacher, tool, object to be taught, or management tool. Ways to fit computers into school practice are also described, including the location of computers in relation to school use. Additional topics include the types of information needed to begin a program; information sources; hardware; software/courseware; staff development programs; and program evaluation criteria. An appendix contains a decision model for microcomputer purchasing; a reference list of periodicals, software review sources, bibliographies, books, and associations; sample software evaluation forms; a partial list of northeast user groups; a partial list of software suppliers; and charts from an August 1981 survey of instructional computer use in public schools in the New York State capital district. (LMM)

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microcomputers in education: an introduction

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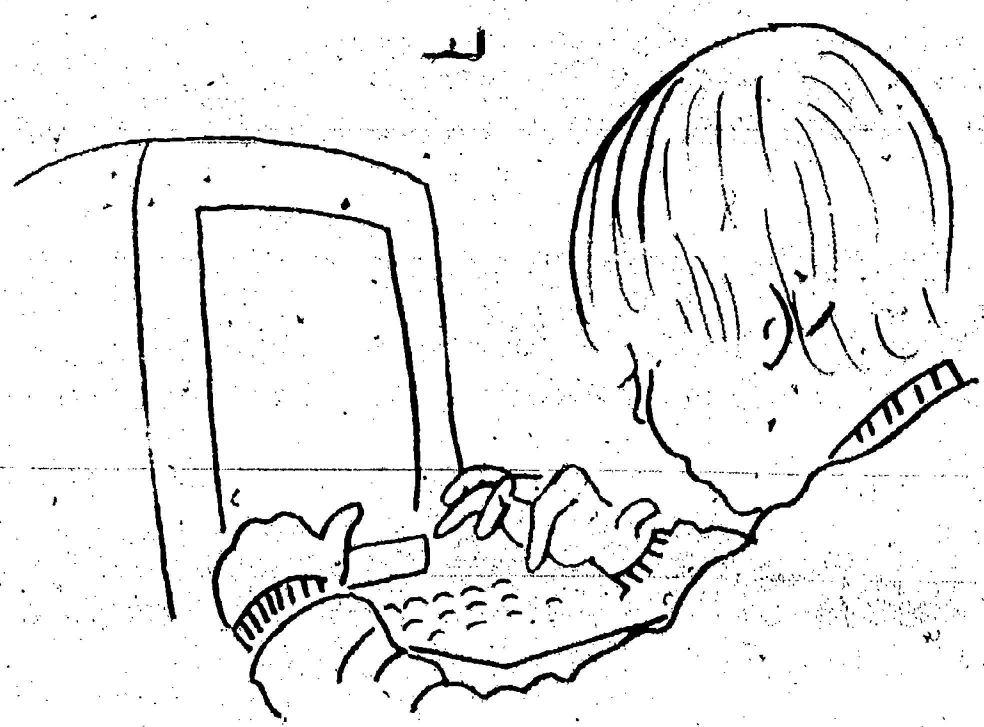

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MICROCOMPUTERS IN EDUCATION
AN INTRODUCTION

BY ADELINE NAIMAN

JANUARY 1982

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The development of this publication was supported through a subcontract from the Northeast Regional Exchange, which is funded by the National Institute of Education, U.S. Department of Education, under grant number NIE G-81-0034. The opinions expressed in this publication do not necessarily reflect NIE position or policy, and no official endorsement by NIE or ED should be inferred.

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CONTENTS

This book reflects the knowledge and support of many people: Bob Tinker and Tim Barclay and the staff of the Technology Center, TERC; Lynn Griesemer and Larry Vaughan and the Task Force on Educational Technology, NEREX; the Computer Education Resource Coalition (CERC); and the many educators who are bringing the "fresh wind" of microcomputers to schools everywhere.

Adeline Naiman
December 31, 1981

I. INTRODUCTION

> Microcomputers seem to carry for teachers and students and administrators alike a refreshing and motivating energy missing from the school scene for a decade or more.
>
> TERC/NREPP Report, May 1980

This book was written to help novices in the educational use of microcomputers, whether they are superintendents or teachers, school board members, parents, or interested citizens. School districts everywhere are making decisions about purchasing microcomputers, and they need help in understanding what issues should concern them, what they should look for, and what kinds of use are possible for their schools.

In the spring of 1980, Technical Education Research Centers (TERC) was invited to carry out a study of microcomputers in education by the Northeast Regional Education Planning Project. NREPP was funded by the National Institute of Education to lay the ground for the establishment of a regional exchange as part of the national network of exchanges. The board of NREPP, comprising the chief state school officers in the six New England states and New York, identified microcomputer use as an area of importance in the region and one needing educational support. TERC prepared a report on the study, including a great many references and resources. When the Northeast Regional Exchange (NEREX) was established, TERC was asked to revise the book, and in December 1981, the present update was prepared. It is based upon the specifications of the NEREX staff and of NEREX's Task Force on Educational Technology, which includes representatives of the seven participating states. It is also based upon TERC's experience over several years, working with school personnel and educators at all levels in the application of microcomputers to education. TERC's national and regional workshops and the open houses of TERC's Computer Resource Center have involved a great many educators - teachers and administrators. Their expressed needs and comments have been helpful in shaping the workshops that TERC offers to help people get started with microcomputers or deepen their understanding of possible uses.

Whether you are a microcomputer buff or a total beginner, you should be able to follow the organization of this book without difficulty and to find the answers to your questions in the text or in the appendices. While some issues are clearly specific to the problems of administrators - funding decisions particularly - most of the information in this book is useful to anyone seeking computer literacy. You don't need any special background to read the book or to apply its suggestions.

Some Background

First, a look at recent history. The microcomputer revolution, as many people call it, is unique in educational experience. For one thing, it is a grass-roots phenomenon. Teachers have become hooked on computers and have introduced them into their classrooms. Parents have pushed on school boards, administrators, and teachers to use computers, and students have brought in their own equipment, creating an enormous pressure for schools to move in step with the change going on outside. Unlike other innovations legislated from above or introduced first by the Federal government, a state department of education, or a district administration, microcomputers first appeared on the scene at the instigation of vendors and manufacturers.

The microcomputer has only been available since 1977, but it has changed the whole nature of thinking about computers as far as schooling is concerned. The case for microcomputers is hard to resist. Their cost is low and steadily declining as new technologies increase the capacity and decrease the size of equipment. They are flexible in their possible uses, and they're portable. The amount of memory a microcomputer now has or can add to its basic repertoire exceeds the storage capacity of the giant computers that in the early years after World War II filled whole rooms and even buildings. Additional memory storage is available for most microcomputers today. Most important, because they are self-contained units, micros are subject to the control of the student and of the teacher, rather than controlling the student according to some remote plan.

For the first time, widespread access to computer use is truly possible. Compare the microcomputer revolution with timesharing - the educational computer revolution that did not happen. Timesharing of giant machines failed to catch on in schools with the same swiftness and spread as microcomputer use for several reasons:

1. Cost. There are several kinds of economies that a microcomputer affords. Since it does not require a telephone connection to a large computer, line charges are eliminated. (The staff of one BOCES in New York State reported that they had shifted to microcomputers because they realized a saving of $12,000 to 15,000 a year in telephone charges.)

2. Portability. Microcomputers can be in a class where they are needed rather than, like a mainframe, in some center to which remote terminals are connected.

3. Reliability. If a microcomputer crashes, it does not wipe out everyone's work. At the very worst, an individual program might be lost, though usually it can be brought back very quickly.

4. Availability. Timesharing leads to competition for computer time, and the mainframe of the past was frequently preempted for administrative uses and only secondarily made available for limited use in instruction, often in the business department and sometimes in the math department, but almost never on a widespread basis across a school.

With the advent of microcomputers, then, a whole new realm of computing has been opened. Although manufacturers at first saw microcomputers as home entertainment devices, they quickly began to realize that the education market was a sizable one and that they should begin to support development of instructional software, as well as the home entertainment and business programs they were prepared to offer. The rapid spread of microcomputers in schools has led to pressure on textbook publishers to jump in and update their curricula with computer programs to supplement existing series, or whole new computer packages to substitute for older texts.

Perhaps no other educational innovation has expanded so rapidly in recent times. The National Center for Educational Statistics (NCES) carried out a nationwide survey of computer use and published a summary report in March 1981. It said, "About one half of the Nation's school districts provide students with access to at least one microcomputer or computer terminal....Microcomputers have come to outnumber terminals proportionally three to two....More than twice as many districts provide microcomputers as terminals...." School districts were asked to report only on interactive use of computers by students (i.e., instructional use), and many districts indicated that they expected to increase the use of computers in the near future. (NCES, March 1981)

What should be noted is that while the presence of microcomputers is increasingly rapidly there are problems: an inconsistent use of the technology, a lag in teacher training, and a scattershot approach to both hardware and software acquisition. Schools are notable for their lack of long-range planning. Introducing microcomputers is an area in which planning is essential, especially in times of tight money.

Although the field is too new for substantial research to have been carried out, some efforts have begun which should help schools apply microcomputers productively. In a preliminary report on a 1981 study by the Bank Street College of Education supported by the National Institute of Education, Dr. Karen Sheingold identified five trends that "raise questions of critical import":

1. Differential access to microcomputers.

2. Emergence of new roles in response to microcomputers.

3. Lack of integration of microcomputers into elementary classrooms and curriculum.

4. Inadequate quantity and quality of software.

5. Lack of knowledge about the effects and outcomes of microcomputers in education.

In addition to these concerns, TERC's extensive work assisting educators has shown other problems to be important:

1. A shortage of preservice teacher education programs.

2. A shortage of inservice programs for teachers and administrators.

3. A lack of systematic information sharing.

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4. The need for Federal funding to support advanced software research, development, and dissemination, and to help schools in poor districts acquire hardware, software, and qualified staff.

Some of these problems will be solved by the naturally arising collaborations of schools (and of individual educators), sharing information, equipment, and courseware, as well as staff and consultants. Such collaboratives exist in most urban centers, and many of them have arisen informally. State agencies, such as the Regional Centers in Massachusetts and the BOCES in New York, serve large numbers of districts with information and resources, but many are only beginning to be helpful in the area of microcomputers. Teacher centers, likewise, are beginning to realize that a prime priority is microcomputer education for their membership. Solutions will be found, but recent cutbacks in Federal and state funding are slowing down the rapid progress that microcomputer use saw in 1977 to 1979. These issues will be discussed in greater detail in later chapters.

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II. The Need for Planning

The most important first step for any school or for any group of teachers is to create a plan for the acquisition and implementation of microcomputers. No single person can carry out a microcomputer program with total success without getting input from school and community representatives. The best plan involves all possible users' points of view both to acquire a variety of perspectives and to build ownership of the outcomes. Microcomputers may be a bargain, but investment in any new technology is expensive and a serious decision for a school or system. You want to get the most out of the funds you have available.

This does not mean that planning should eat up years of time. Most important, as soon as a plan is in place, you should act on it. Don't worry about rapid changes in technology rendering what you purchase obsolete. It's better to get started after a reasonable planning time, since whatever you acquire will be useful. It can always be moved down to a more elementary schooling level if your budget will support further acquisitions. The field of microcomputer use is moving so fast that Education may lose any power to influence the kinds of use that schools make, and users will suffer from the lack of support from the profession. Moreover, without planning, the greatest advances will continue to accrue to wealthier communities and their students, while other less affluent communities may lose out.

A word of caution: if you have already commited available funds to a single brand of machine and you want to change because there are good reasons to vary your equipment, don't feel that you must stick to your original choice and spend your budget adding to the same brand. Different microcomputers are useful for different tasks and curriculum needs. You trade off the economy of supplying software for a single make of machine for the various advantages that different hardware and its software may offer. Some schools started with PETs, for example, because of the three-for-two price break vendors were offering. They still use PETs but have acquired Apples or Ataris in order to teach LOGO or music or other special topics that are not yet available for the PET. Similarly, the Compucolor, which offers many attractive features, has very little educational software, so unless a school or system is willing to develop its own teaching materials or use the machines simply for programming BASIC or for word-processing instruction, it is a limiting choice. Some machines offer color graphics, and this may be important to your curriculum.

Some schools are swapping their original purchases for different equipment, or pooling software, or upgrading memory or other functions of limited machines by adding on peripheral equipment. Software exchanges make it possible to own a variety of machines for different purposes, as well as offering the opportunity to experiment with a range of courseware. You can encourage teachers to develop software; oftentimes, they do it on their own initiative. Some schools pay teachers for extra time, particularly during the summer, in order to develop courseware that is compatible

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with the school curriculum. (Hiring teachers to do summer curriculum development is something schools have done for years.)

The best protection is to start small and get familiar with possibilities before you add on. You can always reinforce your decision with new equipment and new software next year.

Pitfalls

Here are some of the things you should look out for:

1. Moving into bargains without prior planning, staff involvement, or needs assessment.

2. No software budget - schools have found themselves with computers and nothing to teach.

3. The machines selected lack features or software to suit your curriculum needs.

4. No maintenance is available - this is particularly true for systems at a great distance from suppliers.

5. There is no teacher education plan - again, machines have remained idle because of lack of qualified faculty.

6. Letting all microcomputers get stuck in one department - this is particularly a problem at the beginning of a program when you don't have very much equipment. (The tendency is for the math department to get the computers.)

7. Limiting use to gifted and talented students or those needing remediation - not providing access for all students (male and female) or all interested teachers.

8. Using only one mode, such as drill and practice, instead of exploiting the full potential and range of microcomputers - you can kill enthusiasm very quickly if the computer is seen as simply replicating the old workbook.

The Planning Group

The most important single thing you can do to foster successful computer programs in your school is to help create a climate of support, both in the school and in the larger community. If you are an administrator or if you are a teacher, your first planning efforts should be to set up a representative committee involving teachers from different academic departments, as well as the media center, and from different grade levels.

If you're talking about a system-wide computer program then you must involve representatives from all the schools in the system, and be sure that all grade levels are included. (In the past, computer education was seen as natural for high schools, but too expensive for elementary schools. Most educators who are experienced with computers feel that the earlier computer instruction starts, the more students will benefit in the long run.)

Your committee should include parents because their support is essential, both to maintain students in the program and to help with funding and linkages to business and industry. Some parents also have been enthusiastic volunteer teachers to get instruction started, and loaners of their own equipment. You should include administrators from several levels. If possible, the superintendent's office should be represented, the business office of your system, subject-matter specialists, principals, and department chairpeople, as well. It's never too early to get the support of those people who are going to approve funding requests, and in any case for computer literacy to be widespread, it must be part of the total literacy of everyone concerned with education. In many communities, it's possible to get a representative from local businesses, either those that manufacture or distribute or service computers or computer-related functions, or those that utilize computers in their daily work. This is important, because you want community support when budgets get voted on, donations of equipment or instructors' time, and positions to which you can send students for work-study once their skills are established. You also want professional expertise on your committee, but remember that sophisticated engineering or programming knowledge is not enough by itself on which to base educational-computing decisions. Sometimes, enthusiastic parents or business representatives fail to realize that fact at the beginning.

One essential: to the extent possible, every member of the planning group - and you yourself, if you are an administrator - should get some hands-on experience with a microcomputer and some courseware as soon as possible. It will help with the planning process. Try out several microcomputers at a workshop or computer store, or arrange for a demonstration. Use some of the software you might be interested in having. With the help of an instructor, or by yourself with a user's manual, try writing a simple program so that you will get the feel of what students do. Read everything you have time for - newsletters, magazines, journals - dealing with microcomputer use in schools, software, hardware. You can learn a great deal this way. Wherever possible, arrange for a hands-on workshop, or for participation in one given by your system, SEA, or professional organization. Try to include all interested parties over and beyond the planning group itself.

The following list of tasks for the planning group is adapted from one suggested by Kathryn M. Smith of ACES:

1. Analyze your curriculum needs.

2. Investigate and evaluate software. (See Chapter V.)

3. Visit programs in other schools or systems.

4. Attend all possible conferences and vendor demonstrations.

5. Determine your criteria for hardware selection, based on what you want to do and available software. (See Chapter V.)

6. Make a grid with your criteria listed along the side and the available hardware along the top, and decide what you need and can afford. Be sure to include availability of support and maintenance. (See Chapter V. and "Funding Strategies" below.)

7. Work out an implementation timetable for the strategies you think make the most sense (trial period with leased equipment, purchase in stages, summer curriculum development, ongoing teacher education).

8. Develop teacher education and professional development strategies.

9. Establish necessary financial and staff commitments and criteria for success.

10. Establish program evaluation criteria.

11. Get support from staff, parents, community, financial aid sources.

12. Establish ongoing tasks for the planning group, and include re-planning.

Funding Strategies

Although money is tight for new programs, amazingly most schools that have wanted to start a computer program have been able to find support for it from one or another source of funding. A little ingenuity is often called for, but success is possible. Below we will discuss some of the sources of support that school systems have utilized.

1. Regular school budget. Even if money is tight, it's possible to find ways to incorporate a computer program - particularly a microcomputer program - in your school or system budget. The first essential is to start early enough to make sure that you have time to touch all bases in order to generate support and also to revise your request to meet the realities that a particular school may be facing. Some systems have a single computer program that is part of the systemwide budget with equipment, staff, software, and maintenance shared among the schools in the system. In some school districts, individual schools have their own programs and the budget is presented as part of the annual submission to the district for funding. One thing you should consider is getting representatives from several departments in the school together to share costs. This takes careful working out, where it's possible at all, because you must be sure that each department gets its fair share of the use of the equipment and the software is provided for each curriculum need. Again, by pooling resources and having a plan that extends over the long range, schools have been able to acquire equipment that no one department, and certainly no one teacher, could have budgeted.

One way that large mainframe computers were acquired in the past, was to share the use of the central computer with the business office of the school or system and even with town business offices in small towns. This was very practical but it had some drawbacks because of the need to get very clear statements of time allocations. With microcomputers, although they can be linked to form a network and share resources, the basic problem of shared use is that you may not have the computers where you want them for instructional purposes if the business office has pressing need. In general, it is a mistake to share microcomputers between administrative and instructional functions, since the primary need is to get the most time for the greatest number of students.

2. Federal funding and state block grants and other pass-through funding. Until quite recently, most microcomputer purchases are reported as having been accomplished with the aid of Title IVb and Title IVc. Since the end of Title IV funding, state coordinators are hard pressed to find money for local school systems to purchase equipment. Title I is still a major source while it continues, since the use of microcomputers for remedial instruction is widespread. An example of a successful Title I program is the Merrimac Education Collaborative's work in the towns of Northeastern Massachusetts. (Other areas of federal funding that have supported microcomputer programs are the legislation for gifted and talented students, handicapped sutdents, and bilingual students.) In a recent study of New York State's capital districts, the respondents indicated the content areas in which they use computers. The highest use was in math, next remedial, next gifted and talented, and next sciences, with other fields falling far behind. (Willie, August 1981 - see Appendix)

If your system has someone who watches the Federal Register, or the Commerce Business Daily, there may be Requests for Proposals you can bid on, or for which you can be part of a collaborative effort with other school districts, universities, professional organizations, nonprofit agencies, teacher centers, or industry. In the past year, the National Science Foundation and the National Institute of Education have been among the Federal agencies issuing Requests for Proposals to do with microcomputers in instruction. While none of these would support the acquisition of hardware as the purpose of the proposal, your computer education budget could benefit from research or development funds brought in from the outside.

3. State funds under curriculum services, teacher education, elementary/ secondary, educational technology, special education, vocational education. An example of a state agency providing inservice education is the Commonwealth Inservice Institute in Massachusetts, which grants up to $1500 to a school system for a teacher-education program. Because of the pressing need for trained staff to use computers, this kind of program has subsidized much of the development of the computer area in Massachusetts schools. BOCES and state regional centers will often provide in-kind help, as well as teacher education. In some BOCES, equipment is rented to member schools and maintained by the BOCES. The cost saving to the school system is significant, but the greater saving is in the responsibility for maintenance and in the sharing of software and peripherals.

4. Community support. Local businesses can often be called upon to back a school's or system's purchase of microcomputers, either as contribution to the public good, or(with a slight note of self-interest)as students are qualified to take up their places later in the businesses when they finish their formal education. Industry has been supportive in some instances. In one Connecticut city, the school system benefited from the building of new headquarters for a formerly out-of-state company, since the company was interested in attracting employees and making itself welcome in the town.

Although, you can't depend on such sources as PTAs to support a major microcomputer effort in your schools, many a district can point with pride to the initial equipment bought through the activities of an energetic Parent-Teacher Association. Carwashes, bake-sales, benefits have all produced money for targeted purchases. Individual parents and teachers, and students, have often lent or shared their equipment, and parents can be volunteer teachers where qualified faculty are in short supply. High-technology employers can also be sources of support. In Massachusetts and New Hampshire, school districts have been able to get equipment at big discounts after writing proposals to local industry. In some cases, long-term or short-term loans of qualified staff time to train teachers have been arranged with equipment manufacturers. (For example: the Humphrey Occupational Resource Center in Boston has a staff person who is on loan from Digital Equipment Corporation to help establish and maintain the computer education program.)

5. Manufacturers. While not everyone has had success in getting outright grants from computer manufacturers or vendors, several companies have at least made offers of help. The Apple Foundation and the newly established Atari Institute for Educational Action Research are both looking for innovative programs and applications of their computers in education. Apple has supported software development, and Atari is now offering both cash and equipment in its announcements. Control Data Corporation was very helpful to schools in Minnesota in getting started with the programs that have flourished there, and which indeed form a model for state policy and implementation of computers in education. In New England,DEC (Digital Equipment Corporation) and Wang have been important contributors to school programs, and others are joining in. Whether you contact such manufacturers through the corporate giving office or through specific proposals to the marketing department is a question that varies from firm to firm. Certainly, if you have such an employer in your school district, it makes good sense to schedule an appointment for a visit with someone high up to discuss the importance of the company's support of your education program to its own future, as well as the obligation the company should feel to the community in which it is housed.

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III. State Policies, Practices, and Services

The scene in New England and New York, as everywhere, is changing rapidly. Where two years ago, SEAs were not considering anything like a policy in regard to microcomputer acquisitions, microcomputer education for teachers, and software exchanges, now all seven states in the Northeast region are at least working on state-level plans for implementation at local levels. Massachusetts, for example, which had no single person in charge of computer education, now has set up a task force on instructional technology, which has begun meeting under the pressure to deal with this issue constructively.

In this book, we will not deal extensively with either the state policies that are rapidly changing, case studies of practices in the region, or state surveys, some of which are extremely informative. NEREX itself will maintain a file of these. At this point, we will only touch base with the wide range of current policies and practices within the region and outside of it. We have, however, included in the Appendix, portions of a report by Nancy Willie, SUNY/Albany, on "The Instructional Uses of Computers in the Public Schools of the Capital District of New York State." Although the report reflects the responses of only 60 of the 100 districts in the 11-county capital area, it gives valuable information on the ways in which computers are used, software is acquired, and teachers are educated in computer use.

One reason such a variety of state and local policies and programs exists is because of the very nature of the American democracy itself. Within the last two years France announced plans to purchase 10,000 microcomputers for installation in all its schools. England followed with a reported 4,000 microcomputers to be bought for its schools. In the United States, legislators shy away from any semblance of a national curriculum or mandated educational program policy because of the sacredness of local option. This is true on the Federal level, and it is just as true on the state level. A state may issue guidelines for microcomputer selection and purchase over a certain amount, or it may research and recommend particular kinds of equipment or even particular brands of hardware. It refrains from requiring all school districts to buy a single brand of microcomputer.

This has led to such policies as that of the SEA in Nebraska, where schools may buy what they wish, but the state-supported maintenance system will only service Apples. Cost-efficiency is maintained and local option is not denied. Effectively, however, schools are likely to buy Apples.

Similarly in Minnesota, which has the nearest thing to state-controlled educational computing (see below), MECC services only Apples, although it assumes that communities already own or will buy other brands and is itself moving into Ataris.

In some states, decisions fall <u>de facto</u> on intermediary offices or agencies. In New York, purchases of computing equipment must be reviewed

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by the state if they exceed $10,000. Similar constraints exist in other states. As a result, schools buy their micros out of other pockets to avoid losing state reimbursements. (This has become the situation in public and private colleges, as well, where micros are bought out of department budgets to avoid going through the approval procedure for major equipment acquisition.)

Although Title IV funds are no longer available, Title IV guidelines are still used in many states. In Vermont, the following policy was published for ESEA Title IVc:

POLICY ON MINI GRANT APPLICATIONS
REQUESTING A COMPUTER/TERMINAL

A Mini Grant will be awarded to an elementary or a secondary school in a supervisory district/ union for an educational program using a computer if:

A. There is no computer or terminal being used for instruction in an elementary school within the supervisory district/union if the application is for a project at the elementary school level.

B. There is no computer or terminal being used for instruction in a secondary school within the supervisory district/union if the application is for a project at the secondary school level.

C. The proposal includes an educational plan for use of the computer in curriculum areas and does not just address computer literacy.

D. The project includes a plan to share the project activities, results, etc. with other teachers in the district/union of the Mini Grant program.

E. The project meets all other Mini Grant criteria.

New York, by 1980, had developed two de facto standards for schools: TRS-80 Level I for elementary schools; Apple II for secondary schools. This doesn't seem to have constrained either the BOCES or the schools from buying PETS, Ataris, or other machines. A local model is one BOCES plan for leasing micros and peripherals to schools with maintenance and state reminbursement built in; again it is de facto.

Outside New England and New York other programs are worth study. Several are described briefly below.

Minnesota Educational Computing Consortium (MECC)

MECC is nationally known as the only statewide computer education agency. It provides computing services on a timeshare basis, cooperative purchasing, teacher training, software and courseware development and sharing, information, a newsletter, and all manner of ancillary support systems. MECC has seven regional computer service centers. A couple of years ago, MECC decided to go microcomputer and settled on the Apple II (and now the Bell & Howell "black Apple") as the computer of choice. They reasoned that they could provide software and maintenance only to one type of micro, although they recognize that schools will buy others that serve their particular needs better. MECC has carried out an exhaustive study and put out a report, 1979-80 Microcomputer Report, which describes the specifications they agreed on (e.g., no cassettes - must have disk; graphics; etc.). This is a very useful research study and reference. In 1979, MECC bought 1,000 Apples, 100 in one month alone, through an open bidding process. Through such a process, they are attempting to make the chaos of microcomputers in education more manageable. As of this writing, MECC was adding Atari microcomputers to its recommended and serviced micros.

MECC is now an agency of the SEA, the State University System, and the State Administrative Office, all of which send representatives to the governing board, which also includes users of MECC. MECC's policy is determined within limits and overseen by the Minnesota State Legislature.

The Oregon Council for Computer Education (OCCE)

Beginning in 1971 as a volunteer organization of 25 computer education enthusiasts, OCCE now numbers hundreds of individuals from every level of education all over Oregon. It is involved with teacher training, influencing state policy, linking colleges with schools, information sharing. It publishes The Computing Teacher, a newsletter that has evolved into a unique journal for teachers. It has been the chief impetus for a statewide task force on computing education.

Region IV Education Service Center, Houston, Texas

Region IV actually serves three regions of the Texas education system, serving most of the student population of the state. It was established by the Legislature 14 years ago to provide services to schools in the region. The Region IV CAI staff have produced a booklet which is an excellent state-of-the-art resource to educators. The Center collected requests from region schools and put out a bid for group purchase of microcomputers at a low unit cost. In this regard they are following the MECC model described below. The initial purchase was $600,000 worth of microcomputers.

Texas seems to be following MECC's lead, and other states are planning to do so. While in each case, open requests for bids are circulated, the specifications are often so explicit that only one or two brands can match them. This does simplify software sharing and maintenance and gives an edge on purchasing and price.

What none of the existing approaches do is tackle systematically and purposefully the persistent problem of inequity between inner cities and affluent suburbs, or suburbs and rural districts. For this, a national

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priority and funding must be authorized. To date, this has not happened. At the April 1980 hearings of the Congress on Technology in Education, group after group made the point that the power of microcomputers in education is only beginning to be realized and that federal support must be given to providing equal potential for all schools and teachers and students. In the 1981-82 budget cuts, this priority - like many others - has suffered.

IV. Kinds of Uses You Are Interested In and How to Fit Them into School Practice

With the increasing importance of computers in society, and the decrease in computer costs, there is a great deal of interest in using computers and teaching courses about computers in schools. Some ways that computers might be used in the schools are these:

Computer Awareness:	How computers work; how they are used; computer terminology; etc.
Computer Literacy:	Learning how to use one or more computer programming languages; how to interpret computer programs and computer output; how to provide input for computer programs.
Computer and Society	The social impact of computers; impact on jobs, the economy, individual rights, etc.
Computer Programming:	Developing the ability to carry out computer programming projects, using a variety of computer languages.
Vocational Computer Education:	Learning the skills necessary for computer related jobs.
Computer Science:	Understanding the theory of how computers work, how computer languages are designed, etc.
Computer Programming as an Aid to Problem Solving:	Computer programming used to develop cognitive abilities in problem solving, and in specific subject areas, such as math, language, social studies, etc.
Computer Simulations:	Providing simulated "environments" with which students can investigate areas of mathematics, social studies, ecology, physics, etc.
Computer Games for Teaching Logical Thinking:	Many computer games are designed to hold a user's attention and interest while teaching skills of logical thinking.

The Computer in the Laboratory:	Computers can free students from lab drudgery and permit more, better labs.
Business Applications:	Students in accounting and office occupations need to gain skills in word processing, data-base management, and automated accounting.
Programmed Instruction:	Computers are used as "teachers" which provide students with information in subject areas, give tests, and monitor student progress. Students learn at their own pace.
Computer-managed Instruction:	Computers are used to keep records of student progress in any subject area. A profile of student skills and understandings can be available to a student or teacher at any time.
Drill and Practice:	Using computers to provide routine practice in basic skills: arithmetic, spelling, etc. These programs often monitor student progress as well.
Computers for Artistic Expression:	Computers can be used for visual arts, animations, music, etc. Using computers in the arts can aid basic learning in the arts as well as provide motivation for learning computer programming.
Computers as Aids to Handicapped Students:	Computers can be helpful to students who are physically, mentally, or emotionally handicapped, in a variety of modes.
Computers for Remediation:	Basic skills programs that allow students to move at their own speed in an individualized learning role.
Computers for gifted and talented:	Enrichment activities beyond the standard curriculum.

(See also Nancy Willie's Capital District report in the Appendix.)

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A. Some Applications

We have been dividing the many instructional uses of computers into three categories that seem to us to provide a very simple handle on this burgeoning field. To these three - computer as teacher, tool, or object to be taught - we are adding a fourth, the computer as a management tool.

1. THE COMPUTER AS TEACHER (sometimes called CAI or Computer-assisted Instruction). When a computer is used as a teacher, it has been preprogrammed to determine what a student will learn. This can take many forms. Several are named below with sample programs listed.

a. Drill and Practice

Milliken Math - One segment of a K-6 sequence of math activities. This program provides for a certain amount of record keeping and "management" of instruction, as well as practice for the student.

Hartley Early Reading - This program provides practice with word and letter recognition.

Georgia Tech Fractions - An example of a drill-and-practice program which also provides for two modes of learning: visual and numerical. Far too few programs attempt this.

b. Tutorial Programs

Programs designed to teach as well as provide practice. There are few good examples of this type of program for microcomputers. These programs tend to involve a lot of text.

Applewriter Tutorial - This program is provided with the Applewriter word-processing program.

Apple PILOT - Introduces the basic commands and operating system of an early version of PILOT for the Apple.

URSA - A program from MECC (Minnesota Educational Computing Consortium) designed to "teach about constellations."

c. Curriculum-oriented Games

These can make practice more fun, at least for some students.

Darts - A game for practicing fraction concepts from BBN (Bolt Beranek and Newman)

Tax-Man - A game for learning about factoring and prime numbers. (MECC)

Hurkle - Practicing the use of rectangular coordinates. (MECC)

d. Simulations

These game-like activities allow students to make decisions, and interact in situations that are often too complex, historical, expensive, or distant to be brought into the classroom. Students should be trained to evaluate the accuracy of simulations they use. Learning about computer modeling as a technique may be one of the most important effects of using simulations.

Oregon - Make decisions made by travelers on the Oregon trail. (MECC)

Civil - Pretend to be a general in the Civil War. (MECC)

Lemonade Stand -- run a simulated mini-business. (Apple)

Odell Lake - Be a fish. Can you escape from your predators? (MECC)

Dynaturtle - Pilot a rocket ship to a landing in outer space. Develop intuitive insights about Newton's laws of motion. (MIT LOGO Group)

Dynamo - This is a computer language, and a curriculum, designed to allow students to create their own simulations! (Dynamo Project, Lesley College)

Geology Search - Search for oil in a new continent, simulating tests used by geologists. (McGraw-Hill)

e. Logic and Problem-solving Games

This large category includes many classic games which have computer counterparts.

Bagels - A computer version of "Mastermind" (MECC)

Buggy - Find a student's "bug" in doing arithmetic. This one is also a kind of simulation. (BBN)

2. THE COMPUTER AS TOOL, Programs in this category give users some capabilities they didn't have before, making access to certain kinds of learning much easier.

a. Calculators and Statistical packages; Visicalc (an accounting system)

b. Word Processors (for print production and for language arts)

c. The computer as a laboratory instrument, to collect, analyze, and display data and graph real-time experiments.

d. Data-base manipulation, searching.

e. Communications Network. (TERC Cooperative Software Exchange)

f. The Computer in the arts - PAINTER, an "artistic" program that affords another dimension to creativity. Computer music is in the same category. (High School Computer Science Project, University of Tennessee. Now published by McGraw-Hill as Computer Power.)

3. THE COMPUTER AS OBJECT TO BE TAUGHT.

a. Programming a computer - like teaching.

b. Problem Solving. Experiments conducted at the University of Massachusetts)

c. The Computer as a Learning Environment - LOGO/"turtle" graphics (M.I.T.)

A word of caution: Don't lock into one mode or one instructional package. There are ways to incorporate computers productively into almost any teaching area. Look at math, business, science, but also look at language arts, social studies, special education, remedial education, music, art, and other areas that have not been considered traditional ones for computer use. Every week, new software is announced that can fit into a wide range of subject areas.

There is a tendency for schools to think of computers as only useful in computer-assisted Instruction (CAI). In Congressional hearings on Information Technology in Education in April 1980, Dr. J.C. Licklider, Massachusetts Institute of Technology, pointed out that one reason that information technology has not yet led a major impact on education is that -

> The basic philosophy has been incorrect - computers have been used to "push facts into students," but the approach that works best is "to use the computer... to create a stimulating learning environment and to make the computer a partner to the student in exploring and in solving problems."

At the same hearings, Dr. Ernest Anastasio, Educational Testing Service, reported on the outcomes ETS and Dr. Patrick Suppes found in evaluating computer use in CAI. In ETS's NIE-supported study of drill and practice in Los Angeles, the evaluation showed that, "Although test scores increased for children receiving CAI they tended to make the same sort of errors with the same frequency as children that did not receive CAI, suggesting that test-taking skills, not understanding, were improved."

4. THE COMPUTER AS A MANAGEMENT TOOL. Although this book does not intend to deal with the use of microcomputers for school management - i.e., student management or administrative office needs or business office uses - we should point out that a microcomputer can handle the bulk of the computer

needs of a school or small system. The only limitation is the amount of memory required in a large system, and as of this writing, new disk memories exist that give microcomputers extended storage capacity and quick retrieval. Some administrators use computers to monitor student activities, budgets, department budgets, supplies, books, or equipment inventories, attendance, address lists, student schedules, individual academic records, athletic teams and activities, to name a few obvious areas.

Within the administrative uses, of course, is the area of testing. One of the appeals of much computer-assisted software for school personnel is that students' development is tracked and they are, in effect, tested as they go. In our opinion, however, to use computers primarily as a testing device would be to lose the benefit of the enormous range of educationally motivating materials that even now are available and to render the microcomputer merely an animated and self-correcting form of multiple-choice test. The amount of learning and the range of learning styles would be severely limited, and the fresh magic of the computer would very likely be killed for many students. What the microcomputer does make possible is the kind of individualized teaching in which the student paces himself (or herself) against his own expectations and works at his own rate. Using this kind of "self-paced study," the teacher can very quickly see how well each student is doing and where to offer help. (A very interesting study of computers in classrooms was carried out by the M.I.T. LOGO Group in the Brookline, Mass., Public Schools under the direction of Dr. Seymour Papert and Dr. Daniel Watt. The report of this study is essentially a series of case studies of individual students' progress as demonstrated in the computer files and classroom activities.)

All this being said, we should call attention to the whole area of computer-managed instruction (CMI). In a typical CMI system, the student will log in, answer questions, take a brief pre-test that determines what stage of a course the student has mastered, and then receive an assignment to carry out, either on the computer or away from it on a form that can be fed directly into the computer, which then scores the assignment and tells the student what to do next, either on a new topic or as a redo of the initial study. Such diagnostic/prescriptive programs can be very useful when used under a teacher's careful guidance. One danger is that because they are time-saving, teachers will tend to rely on them rather than on their own trained judgment of individual students' development and learning needs. Particularly in connection with special needs or learning-disabled students, the diagnostic aspect of CMI programs may be very helpful. One problem, in our opinion, is that a test is most useful when it serves to instruct, as well as to measure a static point of learning. Another problem is that like all computer software, CMI programs are extremely variable, and some of them seem to develop the art of test-taking rather than mastery of the concept being taught.

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B. Location of Microcomputers in Relation to School Use.

In the early days of computer use, mainframes - because of their size - were often located away from the center of use, while terminals for timesharing were likely to be clustered in the business department or math department. With the advent of microcomputers, some systems sill maintain their micros in the business department or the math department, but new locations are emerging as teachers find out what is most useful to them.

A great deal depends on the number of computers a school or system has available. Ideally, each classroom should have at least one computer to be used as needed in the day's subject areas and for use before and after class and during lunchtime and other breaks. Since at this time, schools have limited numbers of computers, a range of options exist. One popular place to locate microcomputers is in the media center or library because there is always a person on hand to act as at least a minimal resource, and because the media center serves as a central location for all classes. A number of systems in this region have set up computer centers, usually in one school for a whole system and often in the high school of a small system. In larger systems, clusters of classrooms may share the available computers. In times of declining enrollment, it is often possible to set aside a whole classroom for computer use and keep the software library there. Alternatives are to have computers in each classroom, to have a school or systemwide teacher center in which microcomputers are housed, or to have the computers on mobile carts so that they can be wheeled from classroom to classroom throughout a floor or even (with the help of elevators) throughout multistoried schools. This last is cumbersome but possible. Where intermediary agencies exist, such as the French River Teacher Center in Central Massachusetts or several of the BOCES in New York State, the computers and their maintenance people and software and teacher educators can all be located in a single location to serve a wide reach - as many as twenty districts.

While centralized computer resource areas seem to be the wave of the future, we should urge that people not lose sight of the advantages of having at least one computer per classroom, elementary and secondary, in addition. For whole-class use, a number of microcomputers really are essential, since the most important component of computer learning is access to hands-on time. Still, regular computer instruction classes afford only one of the ways in which students can learn, and time to explore outside of formal classroom instruction is a real boon to many students. Moreover, if the computer is to become part of the total classroom environment as many think it must do in the near future, the habit of computer use needs to be established early, and a classroom computer does help to make the resource a commonplace in students' minds.

An important concern is that the computer not be limited as timesharing mainframes were, for the most part, to secondary or vocational schools. Many pedagogical specialists have argued - and we agree - that the earlier students are exposed to a learning tool or environment, the better accomplished they become in its use. No school-age child is too young to carry out some pleasurable and valuable activities with a microcomputer.

In locating the computers where they will provide the best access and the widest use, you should consider, as well, the location of the software library without which computer use is severely limited. If you have a centralized computer room, the library should be there. If microcomputers are located around the building or system, it is a good idea to set up a circulating library of courseware under the charge of the person who can maintain it and schedule its use. If the computer is on a cart, for example, at least some basic software for that computer should be with the machine. Duplicate programs are often necessary with a decentralized system. When teachers or students are encouraged to take a microcomputer home over vacation time or weekends, software should be available to them to encourage productive use of the computer.

A final consideration is ease of hardware maintenance. While microcomputers are extraordinarily hardy, inevitably there are breakdowns, or problems arise which require more knowledge of electronics than the classroom teacher can be expected to have. If your school system can afford it, it is enormously helpful to hire a troubleshooter on staff or on a stand-by basis or to have the vendor train one or more teachers to diagnose and repair common problems. Sometimes a bright high schooler or an electronics hobbyist teacher can serve part time in this capacity. Parent volunteers may help. For most schools, the best solution is to have an arrangement with the nearest computer store or the nearby manufacturer's representative from whom the equipment was purchased. One ingenious solution in a New York BOCES is for all equipment to be owned by the BOCES and leased to the schools. When a breakdown occurs, the machine is replaced instantly with a comparable one as part of the leasing arrangement, and repairs can be made without pressure of time.

Sometimes, you can buy a service policy or warranty with your computers, especially if you are putting out specifications for bidding on a quantity purchase. One cheerful thought is that a microcomputer is light in weight, especially if it does not have an attached display, so it is not too difficult for someone to drop it off at the repair shop or center.

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V. What You Need to Know Right Away

A. Information Sources

The field of computers in education is expanding so rapidly that information is increasingly easy to find (though it may not all be in agreement). It depends what you're looking for information about. If you're looking for general information, there are some very good sources within easy reach.

First, computer stores tend to be full of information. Granted, if the store markets one brand of computers, most of its information will be slanted toward that brand. In addition, until recently, computer store salespeople were not terribly well informed about educational applications, even of their own machines. The same kinds of help are frequently available from manufacturer's representatives who are trying to provide both hardware and a teaching package as incentive to buy. Increasingly, the tail may be wagging the dog as manufacturers realize the dollar potential of curriculum programs.

Because of the fast turnaround time in getting information out, computer journals, educational publications, and all kinds of newsletters tend to be a very good source of information. A handful of these are directly tailored to the needs of school people at the elementary or secondary level or both. General publications will deal with all sorts of issues that concern school people. There are also specialized publications on hardware and on software, including software evaluations. Representative lists of publications can be found in the Appendix.

Books are plentiful. A browse through your local mass-market bookstore or a college bookstore will produce a good armful of hardbound and softbound books aimed at teaching you how to use your personal computer, how to program in BASIC, how to think about the implications of computers in education. While many of these are useful for people who have had hands-on experience or who have a microcomputer at hand while reading, some of them are too specialized or abstruse for the reader seeking preliminary information. Some are provocative: Seymour Papert's Mindstorms has become a best seller. Intentional Educations, a Watertown, Mass., firm is preparing a series of publications aimed specifically at educators, including an introductory volume; Addison-Wesley is the publisher. The National Council of Teachers of Mathematics provides a bibliography of articles about computers from its magazines. The ERIC Clearinghouse on Information Resources at Syracuse University School of Education brings out, from time to time, bibliographies of articles that have appeared in ERIC listings on microcomputer use. While many of these information sources are extremely useful, it would be hard for a beginner to cover all those listings to start with, and the lists are growing everyday.

A major source of information for school teachers and administrators is the user groups that have grown up in many regions around individual brands of microcomputers. Sharing of hardware information and sharing of software are significant parts of their activities. Likewise, informal networks exist in many parts of the country, and throughout the Northeast, often centered on a single group or resource center. For example, the Computer Education Resource Coalition in the Boston area involves several groups whose activities and resources are complementary. Meeting once a month, this group has planned shared activities and has sponsored information exchange. The Boston Computer Society, while its primary interests are not education per se, also serves as a clearinghouse for information about hardware and publishes a magazine that includes a calendar of events in the Greater Boston region.

There are national networks and national organizations that are essential to know about. Such groups as the Association for Educational Data Systems, the Association for Computing Machinery, the Association for the Development of Computer Based Instructional Materials, the National Educational Computing Conference, the Association for Educational Communications and Technology, and the International Council for Computers in Education are useful sources of information. So are the professional associations of school administrators, teachers of mathematics, science, social studies, and English. Another kind of information source is MicroSIFT, the software network based at the Northwest Regional Educational Laboratory and funded by the National Institute of Education. TERC is a source of information through its open house days, workshops, and newsletter, Hands On! These and other resource organizations and networks are listed in the Appendix. Still another information source, once you are started in computers, is the national data bases on various kinds of information or software. Some of these are directly accessible by telephone or computer connection. Don't forget to check with your State Department of Education to see what help and information it provides.

In general, the best way to obtain information is to hook into your local user groups and education networks for ongoing support. National groups will provide you with newsletters, magazines, meetings, and sometimes telephone hotlines. Local groups will provide you with instant support and with experiences that parallel your own because of regional legislation, funding, and social and educational climate. In this respect, microcomputer networks are very like hobby networks - people are generous with their time and help, and the amount of information shared is far more than anyone could afford to purchase.

B. Hardware.

1. Sources. The sources of hardware are obvious; most schools buy directly from a manufacturer or an intermediary, such as a sales agent or a computer store. While some computers are acquired through swaps, loans, or sharing, the bulk are purchased directly by a single institution. In some cases, collective purchasing is carried out and this can be a source of significant savings. Bidding procedures are specified in each state or district, and generally by the time a solicitation for bids is put out, the particular computers desired have been determined by the committee writing the specifications, so what is negotiated is the best deal. Be

careful: the best price is not the only issue for a school to consider - service or maintenance warranties, range of software, free staff training in use and maintenance are all factors for you to think about. The availability of particular software and particular machine capabilities is essential. Do be sure that your computer committee has a chance to try out several kinds of machines and software, and that you yourself, if you are a decision maker, acquire some hands-on experience with the machines and peripherals among which you are choosing.

Before you establish criteria for decision making, you need to set down your objectives for microcomputer education and its place within the school and curriculum. After you make a tentative choice, based on a decision model like the one we include in the Appendix, or like others we refer you to, you should consult the vendor to make sure your choice is a practical one - i.e, that it meets your needs and that the software you want is available for it. The following list of questions that any vendor should be able to answer has been circulated widely, and we have been unable to track down the source, but we reproduce it here because it is so useful.

1. What other schools have purchased this hardware?

2. What successes and failures have they had in its use?

3. What are the reliability statistics on the computer and its peripherals?

4. What documentation exists on the hardware, operating system, and languages? Are there both tutorial and reference materials?

5. How much assistance will the vendor provide in installing and checking out the equipment?

6. What kind of repair support is provided? For example -
   a. Is there a trouble-shooting manual?
   b. Is there a "hot line" telephone service? Toll free?
   c. Will the vendor make repairs on site?
   d. Will the vendor provide you with a "loaner" while your system is being repaired?
   e. Where is the closest walk-in service center to you?
   f. Where is the "mail-in" service center? How long do they take?

7. How much do repairs cost? Is there a fixed fee annual contract available?

8. How long are warranties?

9. What peripherals are provided by the vendor? What peripherals are provided by vendors for this hardware?

10. How does this hardware compare to its competitors for the uses you have in mind?

11. Who is the contact person for the nearest users group for this hardware?

12. What training will the vendor provide in the operation, maintenance and programming of this hardware?

13. Can the vendor relate the technical specifications of the hardware to your user needs?

14. What software exists for this hardware that you need?

2. Microcomputers. All microcomputers currently available offer essentially the same capabilities though they may be programmable in different languages, have specialized software applications to particular fields, have differing amounts of built-in memory, and come with or without certain peripherals built in, such as a display, a disk drive, or game paddles.

The "intelligence" of the microcomputer is the central processing unit (CPU). The fact that the CPU is a single tiny silicon chip has made the microcomputer possible. The steadily decreasing cost of microcomputers is the result of miniaturization which allows much more information to appear on a chip.

Machines vary in the amount of memory they come with but all can expand that memory through the use of add-on memory units or can allow you to store information on disks or cassettes and call it back only when you need it, leaving the built-in memory of the machine free for current programming use. Basically, there are three kinds of memory that a microcomputer may use: "read only memory" (ROM), "random access memory" (RAM), and mass-storage memory. ROM cannot be changed, so it does not "forget" It is used for start-up and for fixed programs. For certain machines, such as the Texas Instruments, the Atari, or the TRS-80 color computer, ROM is supplied in a cartridge that plugs right into the machine. (For some machines, the language is built in, for others it is supplied in ROM or on a disk.)

RAM is the active memory that you can feed into. It "forgets" data when power is removed, so purchased programs are usually in the form of ROM, disks, cartridges, or cassettes that are permanent. For microcomputers, the mass storage device is a cassette usable with a standard tape recorder to load programs, or a small flexible "floppy" disk (often called a diskette). This gives a microcomputer access to large amounts of programs and data. While the first microcomputers tended to come only with cassettes, all microcomputers now have the capability of both cassette and diskette memory storage. Some have built in disk drives, while others require peripheral disk drives. The advantage of the diskette is that it enables you to save and load programs very quickly. It is also easily copied so that you can keep a back-up disk in the eventuality that you lose the original. Since microcomputers have comparatively limited amounts of built-in memory, it helps to be able to store information elsewhere and load it quickly. Using disks also allows several students to program the same computer in turn and take their programs away with them until the next time they get on the machine when they can load their progams in seconds. (Another device that allows you to load the programs of many students into a single microcomputer quickly is a card reader. Students enter their programs onto cards, which are read into the computer. While this a useful peripheral for some purposes, it does not, we feel, provide the learning opportunities that direct programming on a keyboard offers students.)

All microcomputers have keyboards. Most of them are arranged in the same order as a typewriter keyboard, with some specialized additions. Some computers have tiny keyboards that cannot accommodate a normal typing position (the Sinclair is an example of this). Some have touch-sensitive panels rather than actual keys. It is possible to get a more efficient arrangement of keys on some microcomputers, as well as the standard "QUERTY" arrangement.

Computer displays are variable. Some are built in(PET, Compucolor), while others are separate monitors. Some offer high resolution graphics, which means that the images you see are clear,with sharp definition. Some are black and white, while others are in full color. You can use an ordinary television set with any microcomputer by adding a small radio-frequency adapter, but the quality of the image will be less good, less sharp, than it would be on either a black and white or color monitor because the signal has to go through a modulator and a demodulator before it comes out on the television screen. (Note: a color TV will not add color to a microcomputer with only black-and-white capability.)

2. Peripherals are added equipment that may be attached to your microcomputer to add to its capabilities. Peripherals are plugged into specialized "ports" on the sides of microcomputers. There many kinds of peripherals. Game paddles (or joy sticks) make it possible for two students or two teams to interact with certain programs or games simultaneously. The game paddle connection can also be used for hooking up probes to carry out labboratory measurements of temperature, sound, pulse rate, or other physical phenomena. Using the microcomputer as a laboratory instrument for recording and analyzing real-time data takes the tedium out of science experiments.

A printer is a very useful addition to a microcomputer, and with a little ingenuity you can hook up a single printer to several microcomputers to allow it to be used in turn by several students. A printer is essential where students are doing word processing, or language arts in the word processing mode. Then they edit on the screen and print out their disks, coming up with finished copy.

Many kinds of interfaces can be hooked up to your computer to allow specialized activities. For example, a MODEM or acoustic coupler will enable you to use your computer directly with a telephone to send and receive signals to and from another computer. This makes it possible for you to consult data bases at any distance or to connect into large memory-storage systems in your own school mainframe or elsewhere. When you use a microcomputer in this way, you are treating it as if it were a terminal connected to a large computer.

Speech and music synthesizers, special graphics boards, and language cards for additional languages can be added to your microcomputer, thus expanding the range of possible applications. There are digitizing tablets on which you can draw, the picture coming up directly on the display. A variety of very sophisticated peripherals are also available to enable handicapped students to control and benefit from microcomputers.

A microcomputer is an extremely flexible instrument. It can be used to control a range of devices and to act as an intelligent interface with other media. For example, you can make a videodisk player or a videotape machine interactive if you hook it up to a microcomputer used as a control device. The possibilities for interactive learning as well as for information storage and retrieval then become very large, since students can access almost unlimited amounts of stored data - words, numbers, and pictures or movies. They can stop frames and look at actual photographs, as well as the usual microcomputer graphics.

4. Languages. Computer languages are really extended programs designed to enable you to use a computer for particular functions. The language that a computer speaks is very simple - a series of numbers from 0 to 255, amounting to combinations of zeroes and ones in eight-digit units. There's no way we can talk to a machine practically in numbers without a terrifically arduous process of learning the codes by heart, so higher-level languages have been developed which resemble spoken English. Using one of these languages, we can communicate directly with the microcomputer, which has a built-in translator that takes words and numbers and turns them into its own machine language. When information comes out on the display or printer it has been retranslated into the language we started with, but the operations going on within the computer are mathematical, which allows them to go at very high speeds. Virtually all microcomputers use some form of the BASIC language, though each manufacturer has its own version for its own machines, and the different BASICs are not interchangeable. BASIC is a useful language with which to learn programming, and there are many teaching materials already available in BASIC.

BASIC may be in ROM or on a disk. Most higher level languages are only available on disks.

Pascal, a language now available on TRS-80 and APPLE and soon to be available on other machines, allows the development of large programming tasks and calculations. COBOL is available on TRS-80; it is largely a business language. Likewise, FORTRAN is used primarily for mathematical and scientific programming. PILOT is now available on all machines, and it is what's called an "authoring" language for generating CAI material; it makes it relatively simple to write your own programs.

There are sophisticated applications programs, such as VisiCalc, which are, in effect, small languages. VisiCalc is available for most machines and is a very useful accounting program/language, which has other applications as well.

What many consider the most interesting language in the educational repertoire, expecially for young children and for teaching programming, is LOGO. It was developed at Bolt Beranek and Newman and M.I.T. as a language for use with very young students (as well as older students). For many years, LOGO and its subset of activities called "turtle graphics" were available only on large machines. Now LOGO is available on the APPLE II and on the TI99/4. Recently, other companies were licensed to provide LOGO. (As this book was going to press Terrapin, Inc. announced that LOGO is now available from that firm.) LOGO has great attraction for teachers, especially in elementary schools, because of its inherent flexibility and richness. Students learn very quickly to program in LOGO, and since the language closely resembles the form and richness of normal speech, young children find it easier and quicker to learn than BASIC. Teachers, too, are very enthusiastic about LOGO once they have learned to use it. Its applications are particularly useful in mathematics and language arts, where students have carried out sophisticated mathematical and geometrical programs and have written imaginative stories. Since the applications of LOGO grew out of the developmental psychology of Jean Piaget, and since the language benefited from the study of syntax in Artificial Intelligence, LOGO is logical and accessible. It provides a powerful instrument to enable students to learn problem solving and programming skills. (An interesting paper on LOGO by Dr. Daniel Watt of the TERC staff and M.I.T.'s LOGO Group appeared in the December 1979 issue of Creative Computing.)

While you will almost certainly acquire BASIC with your microcomputers, your choice of other languages to add will depend on your curriculum objectives and the range of software available to you to meet these objectives in any other languages.

5. A Decision-making Model. We have developed a decision-making model that starts with a consideration of the desired microcomputer uses and generates a price/performance rating for possible microcomputer systems. Hardware decisions can be easily made on the basis of this final rating. The eight-step model is outlined here and expanded in the Appendix.

This model is similar to models developed by the Pennsylvania Department of Education, among others, and by Dr. Ludwig Braun, who heads computer education activities at SUNY/Stony Brook. Our model avoids the pitfall that many models that involve weighting lead to: the "committee effect" that ends up rating a system highest that almost performs several tasks but is not acceptable for any.

The decision process starts with a determination of your instructional or other objectives for computer use (Step 1). In Step 2, you examine the configuration of the system(s) you need in relation to the uses and consequent complexity and cost. If there are multiple types of use, you need to decide whether the separate uses could be met by different types of computers, or whether use-and-access considerations will force you to purchase a single general-purpose system. In Step 3, the intended uses are refined into a set of functional application requirements, such as, "The system must run LOGO," or "The system will be used for software development." Table I should help you in this refining process.

Once you know what your required functions are, Step 4 converts these into minimum hardware requirements. Table II cross-indexes important functions with hardware and gives minimum needs, as well as rating the importance of certain optional features for each application. This information allows you to take the next step and define one or more complete systems that will accomplish the educational tasks you have defined (Step 5).

In addition to meeting the objective criteria you have set out, these possible systems will have differing performance value on such criteria as reliability, portability, etc. In Step 6, you quantify these criteria and arrive at a rating for each system. The system definitions from Step 5 allow you to arrive at an accurate system cost (Step 7). Finally, the cost/performance ratio is calculated (Step 8) for each system.

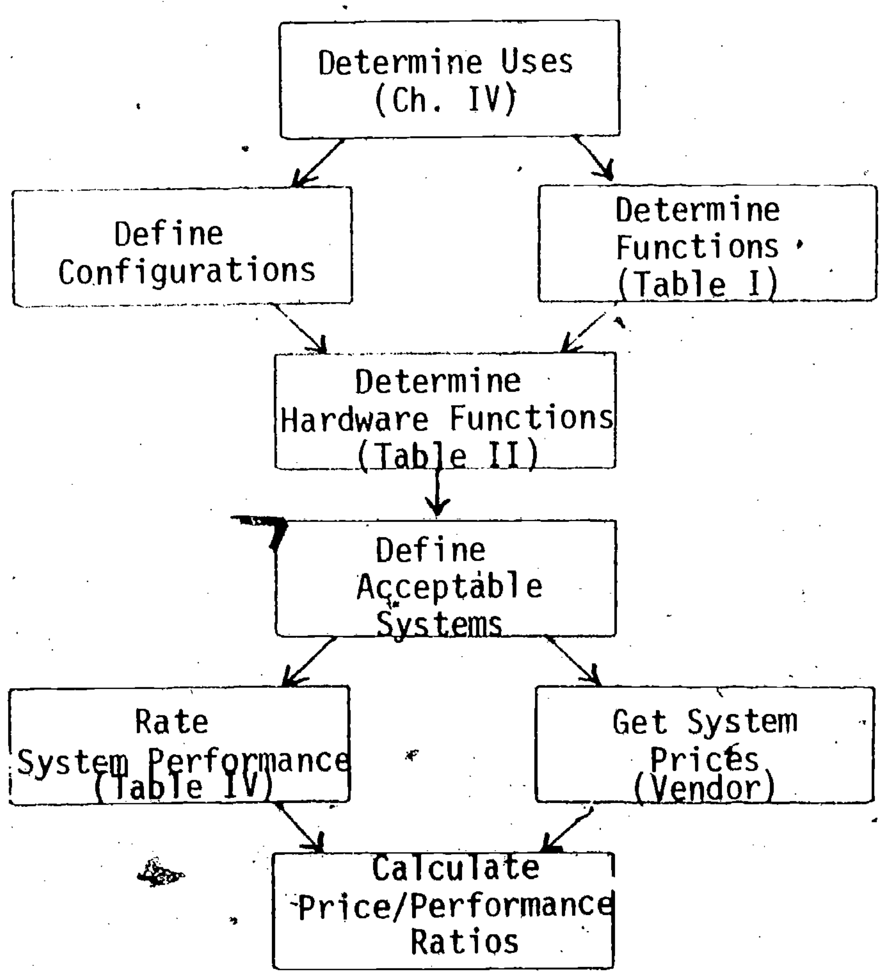

Figure 1. An Eight-Step Decision Model.

C. Software/Courseware

1. Sources. The heart of the use of computers in education is the teaching material that is available to use on the hardware. Hardware development proceeds apace. New models come out each year that outstrip past models in efficiency, range, capability, and lowered cost. Software is proliferating at an enormous rate, but it is much harder to find out about good software. Anybody can sit down with a microcomputer and design a program, so programs are developed by professional educators, programming experts, teachers or teacher teams, publishers, and hardware manufacturers, among others. Finding your way amid the welter of materials that are advertised is a hard job.

One of the most common statements we all hear is, "There isn't any decent software out there." Clearly, that is not true. What is true, is that it's hard to determine what constitutes high quality software without some guidelines that make sense to you as an individual user. Sources of information about new courseware are added every day. Stores offer descriptions of programs, but they tend to link the programs to the particular computers they sell. In many cases, manufacturers offer educational packages whipped together as inducements to buy what were originally intended to be home/personal computers.

Teacher-generated software is extremely variable. Sometimes it is full of bugs or errors. Sometimes it does not work well on the machine for which it was intended. Sometimes it is pedagogically trivial. Occasionally, a teacher will design a piece of instructional courseware that is outstanding (like Tom Snyder's simulations), and often such courseware is available subsequently through a commercial distributor. Occasionally the teacher or other software developer starts a company to produce new materials and market them - a much simpler process than writing your own books and publishing them.

As textbook publishers move increasingly into the computer field, standardization of curriculum materials may increase, but the likelihood is that computer activities will become add-ons to existing texbook series. At a 1981 regional meeting sponsored by the National Science Foundation and the National Institute of Education to examine the use of computers in mathematics instruction, publishers repeatedly affirmed that they were in business for profit and not to take risks. (NSF/NIE Boston meeting, July 7-9, 1981.) The implication was that successful textbook publishers would incorporate computer use but not develop whole new computer-based curricula to supplant their bread-and-butter text series. (In a time of tight money, moreover, publishers are unlikely to provide field representatives who can carry out substantial teacher education.)

Software review periodicals abound. Some of them are the basic resources of anyone concerned with microcomputers and education, and a list of those appears in the Appendix. New directories of software are published at frequent intervals; a number of these are directed at the education market. Some are compendious and too big for easy use. For example, an excellent directory, The International Micro-Computer Software

Directory, contains everything available at this date for microcomputers. Finding educational programs in the midst of all these lists, however skillfully they are arranged, becomes a task in itself.

Software data bases and networks are also prevalent. One of the earliest sources of software for education was CONDUIT, which provided information and programs for college use on mainframe computers. Many of CONDUIT's programs are now available for precollege users and for microcomputers. Another kind of network that provides information on school-related software is MicroSIFT, a project of the Northwest Regional Educational Laboratory. MicroSIFT has a network of evaluators around the country, of which TERC is one. The purpose of MicroSIFT is to collect and evaluate all available educational software, an enormous task. Another kind of network will exist when TERC sets up its software exchange on a national data base, such as The Source. This project is now in process and schools should eventually be able to dial up the data base and get listings and, ultimately, programs to match their specific needs.

At the other end of the software directory scene is the specialized local directory provided by some schools or systems for use within their systems, as well as sharing. MECC in Minnesota publishes both lists of programs and actual programs, many of them developed by MECC as part of the Minnesota computer-related curriculum. On a more local scale, Minuteman Regional Vocational Technical High School in Lexington, Massachusetts, publishes a microcomputer program guide which lists such information as the title of the program, the machines for which it is useful, the content (both in format and subject matter), suggested use, and special comments. Cost and source are provided, as well as the location of the school's copy of the software. Minuteman Tech also puts out Micro-computer News, a periodical that provides basic information and updates of the computer education package. This is just one example of a school-based resource that is available to share within the region and perhaps beyond.

On the commercial level, publishers' advertising and regular listings are information sources. Several magazines publish descriptions of teaching and sometimes actual programs for school use. It is interesting that whole magazines of programs and program listings have begun to be published for the educational market, and educational programs are sometimes included in such general journals as BYTE and Creative Computing. Classroom Computer News includes software in its general educational content, as does The Computing Teacher.

Sorting out what's useful to you from this enormous battery of material is one of the major problems educators face today. Not only are machines different, so that you can't simply use the same software on any available machine but must have a special version for your machine, but also many things are not available across the range of microcomputers in use. This means either that you can't use what you want or teach with it, or that you have to have the ability to modify the program and adapt it to the language of your computer. While people have talked for some years about setting standards for development of computer programs and about providing translators to enable any machine to use the software for any other machine, the present picture is still such that a kind of Tower of Babel is the norm.

In an effort to sort out sense from seeming chaos, some publications do serve as filters on behalf of the educational market. Many of the software periodicals also sell programs directly. Some list software only for one or two machines; others blanket the field. We have found most useful such publications as Queue, School Microware Reviews, Robert Purser's Magazine, The Journal of Courseware Review, Educational Software Directory, and Dr. Dobb's Journal of Computer Calisthenics and Orthodontics, and the Marck Catalogue among others.

2. Software Decisions. All the information in the world will not help if you don't have a plan that guides your software search. In a way, it is impossible to make hardware decisions without thinking about the software that's available for the machines. Certainly buying software without respect to the machine on which it will be used doesn't make sense at all. Part of the critical function of planning ahead must be the examination of available software in relation to the characteristics of hardware required. The same kind of decision plan can be applied to software selection that applies to hardware choice. The list below is of unknown authorship but has been found useful by several states. (We have been unable to find a source to credit.) It is intended for schools to ask software vendors.

1. Are there educators on the vendor's staff who can relate the features of the software to your institution's curriculum?

2. Is there an itemized listing of all instructional software offerings for their hardware?

3. For a given instructional software package, what are the instructional objectives?

4. What evidence is there that the materials assist students in achieving the objectives?

5. Do the materials increase the instructor workload?

6. Will the instructional materials accomplish
   a. Greater learning objectives in the same amount of student time?
   b. Same objectives in less student time?
   c. Greater learning objectives with same total cost per student?
   d. Same learning objectives with lower cost per student?

7. Have materials been reviewed by content experts to assess accuracy of content?

8. How many students were involved in tryouts? Was affective data collected in addition to achievement data? Which educators have evaluated the quality of their instructional software? Does a written validation report exist?

9. Is there a means of doing diagnostic testing? Generating prescriptions automatically? Are individual student records kept?

10. Is there a mechanism for the teacher to monitor student progress? To control assignments automatically?

11. How well are materials documented? For curriculum planner? For teacher? For student? For programmer?

12. Can the program be modified by the user?

13. Would the vendor modify the software to meet the individual needs of your students?

14. How many institutions are currently using the materials? Which ones?

15. How does this software compare to competitive software in the same subject area?

16. What are implementation costs? What are the operating costs?

17. With whom (learner population) was the software validated?

18. Can the objectives be achieved through less expensive means?

3. Evaluating Software. There is no substitute for a teacher trying out a piece of software to determine its utility to his/her curriculum objectives. Sometimes a software library is available locally or at a regional center where teachers can try out programs on a range of machines. Increasingly, we hope, state departments of education will offer this resource both centrally and around the state. Computer stores will allow teachers to try things out, as will manufacturers and their salespeople. The first task, then, is identifying software. The second task is getting hold of it. The third task is by far the most important: evaluating the software once you have it on your machine.

Probably no area or field of computers in education is as fraught with disagreement as software evaluation. Everyone agrees that criteria must be developed to allow educators to make choices. A number of software evaluation forms have been developed by major organizations and by individuals for general-purpose use and for specialized use. These tend to look at different educational objectives and applications from perspectives that don't always match. Ultimately, we would urge each user of educational software to establish an individual or school or system-wide set of criteria - and forms embodying them - which allow for consistent and understandable evaluation. In developing such forms, other people's models may be useful, and we are offering in the Appendix several widely used forms as examples of different educational concerns and objectives. No one form can meet your particular needs, but at least the kinds of questions you may want to ask can be drawn from existing forms as a starter.

You will want to revise your forms after a period of use. One word of caution here: no one who has not taught a particular curriculum can judge the utility of a piece of software for that curriculum without some clever guesses. Similarly, it would take a kindergarten teacher to understand what kinds of activities kindergartners in a particular classroom might respond to and could deal with. It is amazing what kinds of things happen in some commercial software. Not only are there bugs in the "finished" program, but also the language is inappropriate to the grade level or the instructions are hard to follow, or the kinds of responses the computer makes to student input are confidence destroying, even though the software designers thought they were humorous. The central task for an individual teacher/evaluator is to determine the objectives for which the software is going to be applied. If you want a program that will challenge students to think about multiple variables in a computational setting, then a drill-and-practice program is inappropriate. If you want students to learn to write stories, then a spelling program is not right for your purpose, even though you would prefer the stories to have correct spelling.

There are some preliminary things to look for in connection with any program you are considering:

1. Is there documentation - printed support material - to accompany the cassettes or disks? Many programs do not provide documentation, and there is no way for a teacher to get answers to some questions from the program itself, which is preset.

2. Does the program run?* This question may sound foolish, but in fact there are technical problems with many of the programs that arrive over our desks. Some don't go from beginning to end without interruption. Some freeze or stop running when you make a mistake, and there's no visible way to get out of the error without starting all over again.

3. Is the program easy to use? The instructions for proceeding from step to step must be part of the program, so that a student knows what to do at any point. The format should be consistent so that the student gets used to whatever the style of the particular program is and does not have to learn new commands or stop to figure things out.

4. Is the activity educationally sound? A computer program is a piece of instructional material, and the teacher is the best judge of the

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* This and the following questions are adapted from "How to Evaluate Educational Courseware" by Joyce Hakansson, Director of Computer Development at Children's Television Workshop in New York. The article appeared in the first issue of The Journal of Courseware Review, copyright 1981 by the EPEC Evaluation Centre, Foundation for the Advancement of Computer-aided Education, Cupertino, California.

utility of any instructional material.

a. Is the activity appropriate to be integrated into the concepts to be taught?

b. Is the activity appropriate for the age of the students? Is the language? Are the spelling and grammar correct?

c. Are the responses called for reasonable for the students?

d. Is the computer essential to the activity or is it simply being used to juice things up? Would the activity be better in another medium such as print?

e. Is the program attractive and interesting?

5. Who is in control - student or machine? Ideally, the student should be able to determine the length of time an item stays on the screen and should have as much time as needed to read and understand the information before pressing the return key. Allowing the user to be in charge tailors the program to individual needs and helps take away the intimidation that machines have for some students.

6. Does the program present the concept to be learned in a harmonious and well-balanced way? Does it use text and graphics in mutually supportive ways to make the learning more clear? If it has sound, does the sound work well with the other components? Is the text easy to read - are the lines of a reasonable length, does rollover of lines cause confusion, is the color useful or just gimicky? In summary does every piece of the program serve to make it a better teaching item or could it be streamlined to a better effect.

The above are general introductory questions. You will want to develop your own list of more specific questions, based on your teaching philosophy and strategies. For example, if you are using a particular instructional mode, such as simulation, you need to know how the material fits into your teaching program, how it meshes with other components, such as textbooks or hands-on activities, and what extensions of the concepts you wish to teach the simulation makes possible. For computers to be valuable additions to the educational scene, they must be seen as serious components of the teaching approach, not simply enjoyable entertainment. A mistake many people make is to assume that because something is called a simulation or a game, it is for play only. As any social studies teacher who has used Oregon Trail or Geology Search knows, you can often accomplish more within the frame of a computer simulation than with volumes of text. Issues can be brought out that were obscure. Values can become the subject of discussions. Economic trade-offs are graphically depicted, and students finally understand the meaning of abstractions they have read about for years. But unless the individual teacher is comfortable with the mode of presentation and the content, the use of the computer may be an imposition rather than a significant enrichment of the curriculum. Therefore, if possible, teachers need to assess programs before they begin to use them and to incorporate programs into lesson plans and course plans. (The evaluation forms in the Appendix should help you to develop your own evaluation criteria.)

VI. TEACHER EDUCATION

Developing a resource of qualified teaching personnel is one of main considerations schools now face in introducing microcomputers in education. We would add that administrators, too, need to gain at least a minimal understanding of what is involved in the whole instructional use of microcomputers so that they can make informed decisions and cope with problems that may arise, and so that they can be central in the group planning functions.

There are two kinds of staff development, formal and informal. Teachers ask, "What do I need to know to get started?" The process of learning is gradual: awareness, interest, trial/approval, finally adoption. A preliminary step for many teachers is overcoming computerphobia or "technophobia." It makes sense to build on existing strengths of staff and add external sources as you feel you must have them. Here are some suggestions:

1. You may have individual teachers who already know something - get them to teach others.

2. Use students to teach younger students, or employ already knowledgeable students to teach their peers. Certainly, those who already know something will gain from sharing with their classmates, and peer group teaching is often a way to reduce boredom for those who catch on quickly or have prior knowledge.

3. The school or system can provide inservice courses during or outside of class times or on inservice days. These courses can involve specialist staff, outside consultants, or people from other schools or systems. Think about hiring or sharing of specialists in computers. Use parent volunteers to teach staff. Some high technology industries will lend knowledgeable professionals for the short or long term. (We mentioned earlier Digital Equipment Corporation's loaning staff to the Humphrey Occupational Resource Center in Boston.)

4. Push on your state education department, Regional Centers, BOCES, etc., to offer computer education.

5. Some professional associations offer computer workshops at their meetings - NCTM regularly does this. While this is not sufficient, it offers an opportunity to get started or to catch up on new equipment and software.

6. The most important resource area is external training. Your system may provide release time on a regular basis for teachers to take courses, or as has happened in the field of computers, may even provide sabbaticals or mini-sabbaticals for someone in the system to catch up or to learn the ropes so that the learning can be shared with other teachers in the system.

Some colleges offer semester-long or weekend workshops for courses. Intermediary organizations, public or private, like NESDEC, TERC, Columbia

Teachers College Microcomputer Resource Center, etc., provide hands-on workshops. Collaboratives, such as CERC, the Lesley Annual Computer Conference, the Hanover Regional Center, EDCO, the Merrimack Education Center, and The Educational Cooperative offer occasional or regular workshops. The Taft School, Connecticut, Computer Education Institute has an annual summer conference, and the Boston Computer Society has educational presentations. So do user groups, computer stores, manufacturers, and vendors. Sometimes, courses offer credit to participants, and this is an incentive to teachers. Another obvious incentive today is adding skills that will help them stay in their jobs or enter new jobs.

7. Explorations: keep microcomputers available with manuals and start-up instructions and software. It helps if a resource person is close by. You may want to allocate before- or after-school time, or a half-day of in-service time, or Saturdays for explorations, if school is open. You can learn a lot from practice and experiment, but it does help to have a structured support system and to treat exploration as positive. Some schools, as we have mentioned, allow teachers, students, or parents to take micros home overnight or for weekend or even summer use. Machines are hardy, and security problems have been few.

One of the attractions of TERC's Computer Resource Center is its weekly open house, to which teachers come and where they explore on their own, with very little support, the software that is available or the range of machines we maintain. Most teachers, we have found, prefer to work without pressure and without dependence on a formal teaching structure. The manuals and much of the software documentation we have on hand are fairly easy to follow, and this kind of informal self-instruction offers a quick way to catch up on the experience that is the best teacher.

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VII. How will You Judge if Your Program is Successful?

The definition of success in relation to classroom computer use depends very much on the mode of use chosen by the teacher or the school: tutor, tutee, or tool (see Chapter IV, "Some Applications."). If the teacher is using drill-and-practice programs, he or she uses a packaged system that is delivered from the curriculum designer or publisher. To the extent possible, the package is "foolproof" or as some would have it "teacherproof." Students carry out the instruction with minimal challenge to their imaginations, and little originality. The computer programs in such a classroom might be judged successful because students master in a step-by-step way the content of a drill-and-practice or other tutorial exercise. The much touted success of such computer-assisted instruction as Dr. Patrick Suppes' programs, now widely used for remedial work under Title I, is of this kind. Students can be shown to have raised their levels on standardized tests in various subject matters. Success is then quantifiable, but as Dr. Ernest Anastasio, ETS, has commented (quoted in Chapter IV), the students may be said to have learned how to take tests, not necessarily to have mastered an academic concept. While we expect students to make cognitive as well as affective gains through the use of computers, we do not recommend that you measure their learning simply through comparative tests. Nevertheless, the tutorial mode is most frequently found because it requires the least of teachers. Consequently teachers' success could be described as the ability to function as a conduit for pre-packaged material. The program controls the students' learning; that the delivery mechanism is a computer rather than a graded workbook matters only to a limited degree.

Where the computer is serving as tutee, the student is programming and developing teaching material. In this kind of situation, the teacher's success could be described in relation to the students' ability to move independently from learning stage to learning stage through a series of self-designed approximations.

Likewise, the computer as tool - particularly as problem-solving tool - is a model in which the learner is in charge of the learning process, rather than being the recipient of the end product of a sophisticated delivery system.

Most successful classrooms show visible evidence of computers being integrated into the life and learning of the classroom, rather than being limited to a small amount of directed class time. Where computers have made the grade, the teacher often has arranged for the machines to be accessible to students on a flexible basis, so that they may serve as resources in a wide range of subject matters, as well as computer literacy for its own sake.

Another way of looking at different models of use is as follows:

1. Computers are used for teaching computer usage, i.e. programming.

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2. Computers are used for special groups of students, such as, gifted and talented or remedial.

3. Computers are integrated into the regular classroom for all students to use in their coursework.

Yet a different way of categorizing computer use in the classroom is this one:

1. Performance for learning. (cognitive gains).

2. Performance for motivating enthusiasm, initiative, and engagement (affective gains).

3. The use of computers - how they are used, whether they are student-directed, how well they are integrated into the classroom, whether they stimulate questioning, whether they sit in a corner or are an essential and actively used component of classroom teaching (utilization benefits).

In evaluating the success of your program, you will have too look for observational cues that will help you to determine success in each of these categories. Clearly, cognitive gains not necessarily assignable to computer use, as Anastasio has shown in the ETS study, can be documented in several ways: class records and student management information; teachers' observations over time; students' performance on grade-level tests over time if your system routinely gives such tests and maintains comparative scores; and other quantitative measures.

Positive affect toward computers is more easily observable: students engage with microcomputers enthusiastically; they welcome spending time at the machines; they voluntarily come before and after school when a teacher offers independent exploration time or extra structured activities. They take computers home to work with when the school allows such loans on weekends or vacations. They share their discoveries and their problem-solving results enthusiastically with one another and with the teacher and report their experiences at home.

Finally; the kinds of use that can be observed and assessed are those in which students direct the activities of the computer either by developing their own programs or by including computers in several areas of the curriculum and often finding innovative applications for computers. This kind of independent study calls for greater effort on the part of the teacher - in some ways it resembles individually guided instruction - but, teachers report that they profit from the new classroom style, from student motivation and from beneficial outcomes. They say that the introduction of microcomputers into their classrooms has revitalized their teaching, has made curriculum grown stale into wholly fresh material, and has motivated them, their colleagues, and their students more than any single innovation they can recall. As one teacher said, "It's like a fresh wind sweeping through dusty classrooms. It has brought me alive, where I thought I had gone stale on teaching." Part of the visible success that might be associated with microcomputer use is, then, a lively classroom with more active interchange among students and between students and teacher. We would also see greater variety of problem-solving approaches enhanced by the resource of the computer, and more various learning styles because the computer is capable of offering simulations, word problems, information, and instruction in a range of styles that exceed what any one teacher or conventional curriculum can offer.

Perhaps an easy way of answering the question of what constitutes success is to look at its opposite. The classroom in which the computer is reserved for the smallest number of students in a specialized and prescriptive way has not begun to experience the benefits of computer use. Conversely, we should not judge a classroom successful if it served all day as a computer laboratory for student-directed exploration. It is the balance of teacher and instrument that offers a broader array of learning modes and styles to accommodate the needs of many different students and to enhance the teaching of many different teachers.

One problem with trying to determine the success of a single classroom is that a great many factors that encourage teacher success are really due to a systemwide plan for computer use and support of it. These are some criteria gathered from our own and others' experience with microcomputers in education and some questions an administrator might use to assess the success of a computer education program.

1. The school system itself judges the program to be successful, including teachers, students, parents, and the larger community.

   a. Do you think your microcomputer system is successful?
   b. Do you get positive feedback from teachers, students, parents, employers, community representatives?

2. Students are motivated to engage in computer activities even when not required.

   a. Do students ask to use microcomputers outside of class time?
   b. Do you have regular hours for student use, and is there substantial usage?
   c. Do you allow students to take microcomputers home overnight, on school vacations, or on weekends.

3. Non-technical teachers and non-science/non-math teachers are excited about the use of computers and incorporate them into their classroom activities on a subject-related or non-formal basis.

   a. Who uses microcomputers in your school - specialists, math department, science department, business department?
   b. Do elementary teachers use microcomputers?
   c. Do self-contained classroom teachers use microcomputers?

4. Curriculum is modified to reflect the advantages offered by the new technology.

a. Have you revised your curriculum to include use of microcomputers? In what subject areas? For what grade levels?

5. Teachers work together to institutionalize and expand the use of computer-related instruction.

a. Do teachers in your school work together to expand the use of microcomputers?
b. Is there a user group - formal or informal - that meets in your school, in your system, or across systems?

6. The system provides funds for acquisition for hardware and software, teacher training, curriculum revision, and hiring of specialists and/or consultants.

a. Does your system spend its own funds for hardware/software, teacher education, curriculum revision, and the hiring of specialists?
b. Do you pay for release time for teachers to take courses?
c. Do you offer inservice courses?
d. Do you hire teachers to write software?

7. There is evidence of moderation in the use of computers - a balanced and appropriate use of the equipment and software is in evidence.

a. How are computers used in your system?
b. Are they integrated into the regular curriculum without dominating it?

8. There exists a systemwide implementation plan for computers.

a. Does your system now have a long-term plan for acquisition and introduction of computers and computer-related software? Does it include maintenance and teacher education?
b. If not, is such a plan anticipated or in preparation?

VIII. A Final Word

Once you have micros, uses will grow as people become comfortable with working and teaching with them and as they see how time-saving and effective they are and how they motivate even turned-off students and revitalize teaching.

Remember:

1. You don't have to be brilliant to use microcomputers. Slow learners have bloomed, particularly with individual hands-on time, which equals one-to-one teaching, takes away threat of public failure and fear of machines. For some it opens up doors, especially for the handicapped, and also gifted and talented students, for whom microcomputer use affords enrichment, holds interest, and discourages disaffection (let them program software and teach others).

2. Micros hold promise of refreshing teaching and improving the classroom. As with any innovation, you can kill the excitement by using only drill-and-practice materials that replicate workbooks, instead of employing several of the teaching modes that exploit the potential of computers. Diversity is possible, to match the different learning styles of students.

3. Planning is essential - not to slow down your getting started but to make sure you don't have malfunctioning equipment without repairs, hardware without software, computers without teachers, limited use of your investment. (We all remember the boom in audiovisual equipment that ended up unused or unrepaired in closets.) Computers are to be used - they are remarkably easy to use and hard to break.

4. Computers do not substitute for teachers (though they can make teachers' lives much more interesting). They are tools for teachers and students to use (and administrators to use) productively and enjoyably in a variety of ways. They cannot take over the educational process, but they can be integrated into it thoughtfully for everyone's benefit.

5. The success of any educational program is dependent on a supportive climate within a classroom, a school, a system, or the larger community. Try to include everyone in planning for and using microcomputers, and do not restrict their use or control to one teacher, one department, a subject-matter or computer specialist, vocational education, or even to school personnel. Invite parents to hands-on workshops. Invite representatives of government, business, or industry, to play, too, and to see what your students are learning that will make them more knowledgeable and responsible citizens in a technology-based society.

6. Try to build networks and collaborations within your region for sharing information and resources. (Even within the classroom, microcomputers encourage mutually helpful social attitudes.) In a time of tight funding, sharing may solve a great many problems as well as make computer use a cost-effective reality for schools.

APPENDIX

A. A DECISION MODEL FOR MICROCOMPUTER PURCHASING*

Step 1: Determine Your Microcomputer Use Objectives

Begin with your academic and administrative objectives for introducing microcomputers. The more you can narrow these, the more likely you are to succeed and to avoid unnecessary and costly expenditures.

Start with the instructional microcomputer uses listed at the beginning of Chapter IV. To these, add the following non-academic uses:

Software development:	The use of microcomputers to develop instructional software.
Administrative:	Using microcomputers for accounting, record-keeping, word-processing, and similar management applications.
Telecommunications:	The use of a microcomputer as a terminal for access to databases and more powerful computers.

Decide which of these 21 categories you would like to support for which students or other users.

Step 2: Define System Configurations

If your enrollment and proposed microcomputer uses are sufficiently large, you may consider specialized systems for various objectives: a very simple low-cost computer for beginning programming; a moderate-power system for advanced programmers and many other applications; a more costly system for administrative and specialized applications. Apply each system to this eight-step analysis separately.

To aid you in your initial system planning, Table I defines the approximate complexity and cost range of each of the 21 microcomputer uses. This chart is very crude; your needs will be further refined in Step 3 and may force you to reconfigure the system(s) you need.

As part of defining your system configuration, you must determine how many computers are required. Determine the required exposure hours per year per student, multiply by the number of students each year, and divide by the number of students that can use each computer simultaneously. Note that many games and simulations require one computer per class, that 3-5 students per computer is defensible and even preferred in many applications, but that one student at a time per computer is required for many programming tasks.

---

* This model was developed by Dr. Robert F. Tinker, Director of TERC's Technology Center.

TABLE I. Computer Cost and Complexity for Various Uses.

Use	Complexity/Cost: Low	Moderate	High
Computer Awareness	←→		
Computer Literacy	←——	——→	
Computer and Society	NA		
Computer Programming	←——	——→	
Vocational Computer Ed.	←→		
Computer Science		←——	——→
Programming: Problem Solving	←→		
Simulations	←——	——→	
Games	←——	——→	
Laboratory Instrumentation	←——	——→	
Business Applications		←——	——→
Programmed Instruction	←——	————	——→
Computer-managed Instruction		←——	——→
Drill and Practice	←——	——→	
Artistic Expression	←——	————	——→
Aids for Handicapped		←——	——→
Remediating	←——	——→	
Gifted and Talented	←——	——→	
Software Development		←——	——→
Administrative		←——	——→
Telecommunications	←——	——→	

Step 3: Determine the Required Computer Functions

The 21 general use categories must be refined to assist you in making hardware decisions. In some areas there is a particularly wide range of possible hardware. For instance, in teaching microcomputer electronics, you could use inexpensive single-board computers or much more expensive systems, depending on your educational objectives. Examine the functions in Table II and decide which of these categories (or other similar categories) are required to meet the objectives from Step 1.

Step 4: Determine Hardware Functions

Use Table II with the required functions from Step 3 to determine the hardware you need for each system defined in Step 2. Note that Table II may require some revision and extension as the technology changes and uses expand. You should get expert consultant help at this step.

Step 5: Define Acceptable Systems

The results from Step 4 allow you to write a functional specification for the computer system or systems you need to meet your educational needs.

TABLE II. Hardware Requirements of Educational Functions

Function	Memory (RAM)			Disk			Display		Printer	Other Major Peripherals
	8K-16K	16K-32K	32K-64K	5"	8"	hard	color	graphics		
Educational games	3	2	1	2	0	0	2	2	0	1 (Game Paddles)
Beginning BASIC	2	0	0	0	0	0	0	1	0	0
Advanced BASIC	3	2	1	3	0	0	0	2	2	0
LOGO	3	2	2	2	0	0	0	3	0	1 (Turtle)
Machine language	1	1	0	1	0	0	0	0	2	0
Other languages	3	3	2	3	1	0	0	0	3	0
Operating systems	3	3	2	3	0	0	0	0	1	0
Computer electronics	0	0	0	0	0	0	0	0	0	0
Simulations	3	2	1	2	0	0	2	2	0	0
Laboratory instrumentation	3	1	1	2	0	0	0	3	2	3 (Lab Interface)
Word processing	3	3	2	2	2	0	0	0	3	0
Database systems	3	3	2	1	3	2	0	0	3	0
Computer-managed instruction	3	1	2	3	2	1	0	0	2	0
Drill and practice	3	1	0	2	0	0	0	0	1	0
Graphics	3	3	2	2	1	0	2	3	1	1 (Tablet)
Music	3	2	1	2	0	0	0	2	0	2 (Music Synthesizer)
Software development	3	3	3	2	1	1	1	2	3	1
Telecommunications	3	0	0	1	0	0	0	0	1	3 (Serial Interface & MODEM)

Key: 0 Not required
1 Required for some applications
2 Required for most applications
3 Necessary

(Revised 10/82)

Step 6: Rate Available Hardware

The functional specification from Step 5 can, no doubt, be met by more than one hardware system. You now need to rate each acceptable system on its potential performance. Before undertaking a detailed rating, be sure to check to see if the software you need is available for each system.

The usual performance rating system involves the use of weighted criteria. Develop a list of criteria that are important to you, such as transportability, maintenance record, color graphics, etc. Then weight each criterion in proportion to its importance to your particular educational needs. Finally, rate each computer system on each of the criteria, using expert help. The performance rating for a computer is the sum of the products of the weight and rating for each criterion. Table III illustrates this process with typical criteria.

TABLE III. Criteria and Sample Rating Technique

Criteria	Typical Weighting	Sample Rating	Score
Software Availability			
Applications Software	3	2	6
Languages	2	3	6
Future potential	0	1	0
Cost	1	3	3
Support			
Staff training	2	1	2
Maintenance record	3	2	6
Repair availability	1	3	3
Use Considerations			
Speed	0	2	0
Graphics resolution	0	1	0
Expansion availability	1	2	2
Portability	2	3	6
Keyboard quality	0	3	0
		Total Score:	34

Criteria Weighting Scale:
3 very important
2 important
1 optional value
0 of no value

Hardware Rating Scale:
3 a strong point
2 satisfactory
1 not a strong point
0 not available

Note: The criteria and their weighting must be evaluated for each intended application. The values supplied in Table III are for illustration only. The sample rating applies to judgments made on one imaginary computer system - actual ratings are required for each system contemplated.

Step 7: Get System Prices

Determine the expected price for each system that fits the specification developed in Step 5. Do not forget to add related costs, including site preparation, maintenance and repair, materials, and security-related costs. Subtract quantity discounts.

Step 8: Determine the Price Performance Rates

Divide the price (Step 7) by the performance rating (Step 6), for each system. The system with the lowest rating is, in some sense, best. Close scores (within 20%) probably represent equivalence, since the ration depends heavily on your performance-rating system. However, large price performance ratio differences are good grounds for carefully considering the lower-cost system.

See also the following:

Braun, Ludwig, "Help!!! What Computer Should I Buy???" in The Mathematics Teacher, Vol. 74, No. 8, November 1981.

Douglas, Shirley and Gary Neights, A Guide to Microcomputers, Commonwealth of Pennsylvania, reprinted by Connecticut State Department of Education, 1980.

Smith, Kathryn M., "Planning the Best Route to Successful Computer Implementation", ACES Exchanges, Connecticut Area Cooperative Educational Services (ACES), September 1981.

Sturdivant, Patricia, "Selecting a Microcomputer: It's More than the Hardware" and Leroy Finkel, article under the same heading, Classroom Computer News, Vol. 1, No. 6, July-August 1981.

APPENDIX

B. REFERENCES

1. Periodicals

These are only a selection of useful periodicals. New ones come out at frequent intervals. In addition, the publications of many professional organizations and many groups concerned with educational technology in general have often devoted whole issues to microcomputer use. Newsletters are prime sources of information in this field; most regional centers and associations will put you on their mailing lists.

Boston Computer Update
Boston Computer Society, Inc.
Three Center Plaza
Boston, MA 02108

BYTE
Byte Publications
70 Main Street
Peterborough, NH 03458

Classroom Computer News
P.O. Box 266
Cambridge, MA 02138

Note: The July-August 1981 "Compendium" issue (Vol. 1, No. 6) is a prime source of up-to-date information for educators.

ComputerTown USA! News Bulletin
P.O. Box E
Menlo Park, CA 94025

The Computing Teacher
Computing Center
Eastern Oregon State College
La Grande, OR 97850

Creative Computing
P.O. Box 789-M
Morristown, NJ 07960

C.U.E. Newsletter
Computer-using Educators
Dr. Sandy Wagner, Editor
127 O'Connor Street
Menlo Park, CA 94025

Dr. Dobb's Journal of Computer Calisthenics and Orthodontia
Box E
Menlo Park, CA 94025

EDU, Educational Products Group, Digital Equipment Corp., ML5-2/M40, Maynard, MA 01754

Educational Computer Newsletter
P.O. Box 535
Cupertino, CA 95015

Electronic Learning
902 Sylvan Avenue
Englewood Cliffs, NJ 07632

ERIC/IR UPDATE
Syracuse University School of Education
130 Huntington Hall
Syracuse, NY 13210

Hands On!
TERC
8 Eliot Street
Cambridge, MA 02138

Instructional Innovator (AECT Publication)
1126-16th Street, N.W.
Washington, D.C. 20036

Interface Age
16704 Marquardt Avenue
Cerritos, CA 90701

Journal of Computers in Mathematics and Science Teaching
P.O. Box 4455
Austin, TX 78765

Kilobaud Microcomputing
Wayne Green, Inc.
80 Pine Street
Peterborough, NH 03458

The Mathematics Teacher
National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091

Note: The November 1981 issue (Vol. 74, No. 8) is a special issue on microcomputers. It has excellent articles on choosing hardware and software. All issues include very useful software reviews.

Micro-computer News
Minuteman Tech
758 Marrett Road
Lexington, MA 02173

On Computing
P.O. Box 307
Martinsville, NJ 08836

Pipeline
CONDUIT
P.O. Box 388
Iowa City, IA 52240

Recreational Computing
P.O. Box E
1263 El Camino Real
Menlo Park, CA 94025

T.H.E. Journal
Information Synergy
P.O. Box 922
Acton, MA 01720

2. Software Review Sources

Most magazines and journals (and many newsletters) dealing with microcomputer use in education include software reviews on a fairly regular basis. In addition, there are many software directories listing available courseware by grade level, subject matter, etc. Some of these (such as School Microware Directory, K-12 Micro Media, Purser's Directory, the Marck Catalog, and QUEUE are very helpful in determining what's out there. So are the catalogs and directories put out by vendors (see Software Vendors list). The following is a brief list of sources of reviews of educational software. Often the reviewing is done by teachers.

EPIE Institute
(in collaboration with Columbia Teachers College
Microcomputer Resource Center)
P.O. Box 620
Stony Brook, NY 11790

The Journal of Courseware Review
Foundation for the Advancement of Computer-aided Education
20863 Stevens Creek Blvd.
Building B-2, Suite A-1
Cupertino, CA 95014

Microcomputers in Education
Queue, Inc.
5 Chapel Hill Dr.
Fairfield, CT 06432

MicroSIFT
Northwest Regional Educational Laboratory
710 S.W. Second Avenue
Portland, OR 97204

Pipeline
CONDUIT
P.O. Box 388
Iowa City, IA 52244

Robert Purser's Magazine
P.O. Box 466
Eldorado, CA 95623

School Microware Reviews
Dresden Associates
P.O. Box 246
Dresden, ME 04342

3. Bibliographies

Friel, Susan and Nancy Roberts. "Computer Literacy Bibliography." Creative Computing, Vol. 6, No. 9 (September 1980), pp. 92-97.
Annotated bibliography of books concerned with computers and social issues, programming, and teaching resources.

Hall, Keith A. Computer-Based Education: The Best of ERIC, June 1979-August 1980. Syracuse, New York: ERIC Clearinghouse on Information Resources, November 1980.
Update of an earlier ERIC Bibliography of articles on educational technology.

Kosel, Marge. "Computer Bibliography" in The Mathematics Teacher, Volume 74, No. 8, November 1981.
Annotated bibliography of computer books available for secondary schools. Topics covered include student textbooks, resources, periodicals, and a list of organizations.

NCTM, Computers in Education, National Council of Teacher of Mathematics, 1906 Association Drive, Reston, VA 22091. Listing of articles from The Mathematics Teacher and The Arithmetic Teacher.

4. Books

Douglas, Shirley and Gary Neights, A Guide to Instructional Microcomputer Software and A Guide to Microcomputers. Pennsylvania Department of Education, reprinted by Connecticut Department of Education; 1980.
Excellent introductions with step-by-step guidelines for setting up microcomputer-based instructional systems.

Edwards, Judith B., et.al. Computer Applications in Instruction: A Teacher's Guide to Selection and Use. Hanover, NH: Time Share Corp. 1978.
A good overview of computer applications with lots of examples and diagrams. Not detailed enough in any area but a good start.

Intentional Educations. Computers in Education: A Practical Guide. Reading, MA: Addison-Wesley. 1982 (in press).
An excellent first book for educators. Included are examples of applications, evaluation criteria, and implementation strategies. This book is part of a series that will treat evaluation issues in various subject areas, such as reading, math, and administration.

Olds, Henry, et.al. People and Computers: Who Teaches Whom? Newton MA: Education Development Center, Inc. 1980.
A concise descriptive and explanatory document that should be read by educators who want to work with computers. Powerful theoretical framework, methodology, and insights derived from research.

Papert, Seymour. Mindstorms: Children, Computers, and Powerful Ideas NY: Basic Books, Inc. 1980.

Taylor, Robert P. (ed.). The Computer in the School: Tutor, Tool, Tutee. NY: Teachers College Press. 1980.
A good solid compilation of articles related to educational applications for the computer.

5. Associations Helping Educators Use Microcomputers

Association for Computing Machinery
(ACM)
1133 Avenue of the Americas
New York, NY 10036
(212) 265-6300
Contact: Member Services

Local Chapters and SIGS. Many publications.
Education for Elementary and Secondary Schools (Order No. 812810, 1981, 92 pp., $7.00 for members, $10.00 for nonmembers) can be purchased from the ACM Order Department, PO Box 64145, Baltimore, MD 21264.

Association for Development of Computer-Based Instructional Systems,
(ADCIS)
ADCIS Headquarters
Computer Center
Western Washington University
Bellingham, Washington 98225
(206) 676-2860
Contact: Gordon Hayes, Executive Secretary
Bimonthly newsletter and Journal of Computer-Based Instruction, free to members, special Interest Groups.

Association for Educational Communications and Technology
(AECT)
1126 16th St. N.W.
Washington, DC 20036
(202) 833-4186
Taskforce on microcomputers. ECT Journal and other publications.

Association for Educational Data Systems
(AEDS)
1201 Sixteenth Street, N.W.
Washington, DC 20036
(202) 833-4100
Contact: Shirley Easterwood, Executive Secretary
Three quarterly publications - Bulletin, Monitor, Journal, free to members.
International conventions, seminars, workshops, programming contest for students 7-12.

International Council for Computers in Education
(ICCE)
Department of Computer and Information Science
University of Oregon
Eugene, Oregon 97403
(503) 686-4405
Contact: David Moursund
The Computing Teacher, 9 issues per year, $14.50; also booklets.

Microcomputer Resource Center
Teachers College, Columbia University
Macy Hall
New York, NY 10027
(212) 678-3740
Contact: Karen Billings, Director
Workshops, information resources, newsletter.

National Educational Computing Conference
(NECC)
University of Missouri, Computer Services
305 Jesse Hall
Columbia, MO 65211
Contact: E. Michael Staman, NECC-82, General Chairman
A distinguished steering committee plans annual meetings at which papers are delivered.

New England School Development Council
(NESDEC)
85 Speen Street
Framingham, MA 01701
(617) 876-7624
Contact: Dr. Jack Sullivan, Director
Runs workshops and conferences on issues of concern to decision makers.
In 1982, NESCEC is hosting a series of workshops on microcomputers in education which TERC is presenting.

Northeast Regional Exchange (NEREX)
101 Mill Road
Chelmsford, MA 01824
(617) 256-3987
Contact: Larry Vaughan
Part of the national network of resource exchanges, NEREX supports workshops, information dissemination, and this book.

Society for Applied Learning Technology (SALT)
50 Culpepper Street
Warrenton, VA 22186
(703) 347-0055
Contact: Raymond G. Fox, President
Quarterly newsletter free to members, a journal, and other publications.

Technical Education Research Centers (TERC)
8 Eliot Street
Cambridge, MA 02138
(617) 547-3890
Contact: Tim Barclay
Computer Resource Center, workshops, open house days, newsletter, Hands On!

APPENDIX

C. SAMPLE SOFTWARE EVALUATION FORMS

We are reprinting here, with permission, sample evaluation forms used by established software review groups. They are intended to serve as suggestive models only, since your school planning group will want to develop its own form, and since you need permission to reproduce most of these.

See also the following:

Douglas, Shirley and Gary Neights, A Guide to Instructional Microcomputer Software, Pennsylvania Dept. of Education, reproduced by Conn. Dept. of Education, 1980.

Gould, Thomas M., "Copyright Laws," The Computing Teacher, Vol. 8, No.5, April-May 1981.

Hakansson, Joyce, "How to Evaluate Educational Courseware," The Journal of Courseware Review, Vol. 1, No.1.

Kansky, Robert, William Heck, and Jerry Johnson, "Getting Hard-nosed About Software: Guidelines for Evaluating Computerized Instructional Materials," The Mathematics Teacher, Vol. 74, No.8, November 1981.

Koetke, Walter, "Software Shopping," Kilobaud Microcomputing, July 1981.

Lathrop, Ann, "Software...PREviewing and REviewing," Educational Computer Magazine, September-October 1981.

"A Level-headed Guide to Software Evaluation," Classroom Computer News, Vol. 1, No.6, July-August 1981.

Moursund, David, "Some Thoughts on Reviewing Software," The Computing Teacher, Vol. 7, No.6, June-July 1980.

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1. Describe Package Content and Structure.

	RATING (Strongly Agree / Agree / Disagree / Strongly Disagree)	Not Applicable	WEIGHT (High / Medium / Low)		
CONTENT	SA A D SD	NA	H M L	2.	Content is accurate.
	SA A D SD	NA	H M L	3.	The content has educational value.
	SA A D SD	NA	H M L	4.	The content is free of race, ethnic, and sex stereotypes.
INSTRUCTIONAL QUALITY	SA A D SD	NA	H M L	5.	The purpose of the package is well-defined.
	SA A D SD	NA	H M L	6.	The package achieves its defined purpose.
	SA A D SD	NA	H M L	7.	Presentation of content is clear and logical.
	SA A D SD	NA	H M L	8.	The level of difficulty is appropriate for the target audience.
	SA A D SD	NA	H M L	9.	Graphics/color/sound are used for appropriate instructional reasons.
	SA A D SD	NA	H M L	10.	Use of the package is motivational.
	SA A D SD	NA	H M L	11.	The package effectively stimulates student creativity.
	SA A D SD	NA	H M L	12.	Feedback on student responses is effectively employed.
	SA A D SD	NA	H M L	13.	The learner controls the rate and sequence of presentation and review.
	SA A D SD	NA	H M L	14.	Instruction is integrated with previous student experience.
	SA A D SD	NA	H M L	15.	Learning is generalizable to an appropriate range of situations.
TECHNICAL QUALITY	SA A D SD	NA	H M L	16.	The user support materials are comprehensive.
	SA A D SD	NA	H M L	17.	The user support materials are effective.
	SA A D SD	NA	H M L	18.	Information displays are effective.
	SA A D SD	NA	H M L	19.	Intended users can easily and independently operate the program.
	SA A D SD	NA	H M L	20.	Teachers can easily employ the package.
	SA A D SD	NA	H M L	21.	The program appropriately uses relevant computer capabilities.
	SA A D SD	NA	H M L	22.	The program is reliable in normal use.

23. CHECK ONLY ONE

____ I would use or recommend use of this package with little or no change. (Note suggestions for effective use, next page.)

____ I would use or recommend use of this package only if certain changes were made. (Note changes under major weaknesses, next page.)

____ I would not use this package. (Note reasons under major weaknesses.)

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24. If you would consider using this package describe procedures for its effective use in specific classroom settings.

25. List one or two major strengths of the package with supporting comments.

26. List one or two major weaknesses of the package with supporting comments.

27. [ ] In the box at the left, indicate your overall opinion of this package by writing an integer from 1 to 10 (10 being the high value).

Copyright 1980, Northwest Regional Educational Laboratory
11/80 Field Test Version

COURSEWARE EVALUATION FORM

Name of program ______________________________

Manufacturer's or distributor's name ______________________________

Address ______________________________

Cost __________ Copyright/date ______________________________

Available for what microcomputers (model and memory) ______________

Peripherals needed ______________________________

Reviewer's name ______________________________ Date __________

Description of program ______________________________

____

____

Appropriate grade level: primary inter. jr high sr high college

Type of computer application(s) (check one or more)

___ simulation
___ tutorial
___ drill and practice
___ game
___ problem solving
___ remediation
___ enrichment
___ management (only)
___ diagnostic/prescriptive
___ other __________

Kinds of courses for which this program is appropriate

____

Prerequisite skills or courses needed

____

ANALYSIS (check yes, no or not applicable)	YES	NO	NA
a. Content has clear instructional objectives.	___	___	___
b. Content is accurate.	___	___	___
c. Content has educational value.	___	___	___
d. Content is free of stereotypes.	___	___	___
e. Content expresses positive human values.	___	___	___
f. Program is appropriate for targeted audience.	___	___	___
g. Computer branches to appropriate difficulty.	___	___	___
h. Graphics/sound/color have instructional value.	___	___	___
i. Frame display is effective.	___	___	___
j. Students can use program easily.	___	___	___
k. Teachers can utilize the program easily.	___	___	___
l. Documentation is comprehensive.	___	___	___
m. Computer is an appropriate tool for activity.	___	___	___
n. User can control rate/sequence/directions.	___	___	___
o. Feedback used is effective and appropriate.	___	___	___

RECOMMEND for purchase? ___yes ___no ___conditional on:

Permission to reproduce for classroom use by Microcomputer Resource Center, Teachers College, Columbia University, New York, New York.

SCHOOL MICROWARE EVALUATION FORM

(This form may be copied as needed; for additional information, see School MicroWare Vol. 1 No. 1)

Your Name ______________ Organization ______________ Position ______________

Product Name ______________ Supplier ______________ No. of Progs. Under This Name ______ Price $ ______

Applicable School Dept/Subj/Topic ______________

INSTRUCTIONS - For open ended items, supply all information requested in blanks provided if possible; use extra sheets if necessary. For objective items (those with blanks to left), enter a number in the blank to indicate the extent to which the program fulfills the description in the item, as follows: 2 - Completely, 1 - Partially, 0 - Not at All. If the item is not applicable to the program, enter N/A. If the item is unclear, enter U. Elaborate on answers as necessary in Comments section at end or on extra sheets, giving item numbers.

OVERVIEW - Describe the program briefly in terms of its goals and what it does to achieve them (no evaluation here).

____

____

PRELIMINARY CONSIDERATION - Assuming that this program contributes to the teaching of one or more topics, is that topic one which is or should be taught in today's schools? Yes No If not, give your reasons for this answer in the Comments section at the end of the form and omit the balance of the questionnaire.

DOCUMENTATION - List materials accompanying the program, e.g., teachers guide, student workbook.

1. Indicate types of information included.
   - ----- a. Suggested course/subject, grade levels.
   - ----- b. Goals.
   - ----- c. Performance objectives.
   - ----- d. Suggested teaching strateg(ies).
   - ----- e. Correlation with standard texts.
   - ----- f. Prerequisites for use of program.
   - ----- g. Student exercises, teacher answers.
   - ----- h. Operating instructions.
   - ----- i. Listing and sample runs of program(s).
   - ----- j. If a simulation, description of the model used.
   - ----- k. Suggested topics for follow-up discussions.
   - ----- l. Suggested references/activities for follow-up.
2. ----- The documentation is written clearly.
3. ----- If a workbook is included, the format and content are appropriate.

INSTRUCTIONS GIVEN TO USER BY PROGRAM

1. The instructions are adequate regarding:
   - ----- a. The instructional task to be performed.
   - ----- b. Details of how to interact with the program.
2. ----- User has the option of skipping instructions if already known.

STUDENT-COMPUTER DIALOG

1. ----- Output is displayed screen by screen (paged) rather than scrolled.
2. If output is paged:
   - ----- a. User has control over continuing to the next page.
   - ----- b. Amount of information in each page is appropriate.
   - ----- c. The perceptual impact (amount of type and lines) is suitable.
3. ----- Output is spaced and formatted so as to be easily readable.
4. ----- Language is well suited to most students' reading ability.
5. ----- Uses correct grammar, spelling, hyphenation and punctuation.
6. ----- Any grid or coordinate system used is consistent with common conventions.
7. ----- Students can respond with common symbols & ways of using them, e.g., right to left entry of sums.
8. ----- Accepts abbreviations for common responses.
9. ----- Provides for individual needs, e.g., opportunity to work with harder or easier material.
10. ----- Dialog is personalized, i.e., makes appropriate use of student names.
11. ----- Uses devices to get & maintain interest, e.g., variation of computer responses, humor, pace change, surprise.
12. Makes good use of any special features of computer:
    - ----- a. Graphics
    - ----- b. Color
    - ----- c. Sound
13. ----- Reinforcing responses (indications of right, wrong, etc.) are appropriate.
14. ----- The number of wrong answers allowed is reasonable.
15. ----- Responds appropriately if allowed number of wrong answers is exceeded.
16. ----- Provides opportunity to get help if difficulty is encountered.
17. ----- Minimizes bad entries via devices such as objective formats (multiple choice, etc).
18. ----- Deals well with inappropriate entries, i.e., response to typing errors, etc., is intelligible and useful.
19. ----- Required entries are within students' capabilities (esp. typing, vocabulary).
20. ----- Reports student performance periodically and at end of session.

MISCELLANEOUS CONCERNS

1. ----- If a simulation, the program gives a sufficiently accurate representation of the situation simulated.
2. ----- The concepts and vocabulary required to use the program are reasonable.
3. ----- Operates properly and is free of bugs.
4. ----- Is well structured and documented internally to facilitate any necessary debugging/modification.

COMMENTS - Please use this space and additional sheets as necessary to provide any other information which you believe would help someone who was considering acquiring the program being reviewed. In particular, indicate what you like least and most about the program. Also, list any changes which should be made.)

____

____

ERIC

BEST C

Educational Software Evaluation Form

© Educational Alternatives, 1981

Program Name ____________ Producer ____________ Cost ________
Subject Area ____________ Reviewer ____________ Date ________

1. Describe the intended educational purpose:

2. Instructional Range: Grade levels ____________ Ability levels ____________

3. Instructional Grouping: Individual ____, Small group (size) ________ large group (size) ______

4. Program uses: Drill and practice ___ Tutorial ___ Simulation ___ Instructional Game ___ Strategy game ___
   Problem solving ___ Information Source ___ Software tool (type) ________ Other ________

5. Comment on Appropriateness for Instructor:
   To what extent does the program allow a teacher to adjust for different uses and different users?

   To what extent does the program require teacher assistance?

   What is the implied view of the learner and the learning process?

   Is the program educationally appropriate?

6. Comment on Appropriateness for Student:
   Are the directions clear?

   Is it simple to use?

   Is it developmentally appropriate considering physical, intellectual and emotional maturity?

   Would most of your students enjoy using this program? ___ If not, describe those who would.

7. Comment on:
   The instructional significance of the program:

   The compatability with educational philosophy, teaching style and curriculum generally encountered by the student:

Reviewer's Name__________

Program Name__________

8. What happens when a student makes a mistake in <u>entering answers</u>?

   What happens when a student makes a mistake in <u>content</u>?

9. Can the student get help from the program?

   Can the student review the instructions once the program has started?

10. To what extent is the user given choices?

    To what extent does the user feel in control?

11. Indicate the social characteristics present:

	present & negative	present & positive	not present
competition			
cooperation			
personification of the computer			
moral issues and value judgements			
appropriate inclusion of women& minorities			

12. Describe any <u>un</u>intentional learning, both positive and negative:

13. To what extent does the program use the computer's potential for interaction, immediate feedback, animation, color, music, sound, etc.?

14. To what extent does the program offer more than one mode of learning (visual, verbal, numerical, aural), in a way that reinforces and supports the learning focus?

15. In what ways (and under what circumstances) can this program provide students with a more effective learning experience than they could have had without a microcomputer?

16. Briefly support your reccomendation for_____ or against_____purchase of this program by your school system:

SOFTWARE EVALUATION CHECKLIST

PROGRAM NAME: ______________ SOURCE: ______________ COST: ______________

SUBJECT AREA: ______________ REVIEWER'S NAME: ______________ DATE: ______________

1. INSTRUCTIONAL RANGE

______________ grade level(s)

______________ ability level(s)

2. INSTRUCTIONAL GROUPING FOR PROGRAM USE

_____ individual

_____ small group (size: _____)

_____ large group (size: _____)

3. EXECUTION TIME

_____ minutes (estimated) for average use

4. PROGRAM USE(S)

_____ drill or practice

_____ tutorial

_____ simulation

_____ instructional gaming

_____ problem solving

_____ informational

_____ other (______________)

5. USER ORIENTATION: INSTRUCTOR'S POINT OF VIEW

low				*high*	
·	·	·	·	·	flexibility
·	·	·	·	·	freedom from need to intervene or assist

6. USER ORIENTATION: STUDENT'S POINT OF VIEW

low				*high*	
·	·	·	·	·	quality of directions (clarity)
·	·	·	·	·	quality of output (content and tone)
·	·	·	·	·	quality of screen formatting
·	·	·	·	·	freedom from need for external information
·	·	·	·	·	freedom from disruption by system errors
·	·	·	·	·	simplicity of user input

7. CONTENT

low				*high*	
·	·	·	·	·	instructional focus
·	·	·	·	·	instructional significance
·	·	·	·	·	soundness or validity
·	·	·	·	·	compatibility with other materials used

8. MOTIVATION AND INSTRUCTIONAL STYLE

passive				*active*	
·	·	·	·	·	type of student involvement

low				*high*	
·	·	·	·	·	degree of student control

none	*poor*				*good*	
·	·	·	·	·	·	use of game format
·	·	·	·	·	·	use of still graphics
·	·	·	·	·	·	use of animation
·	·	·	·	·	·	use of color
·	·	·	·	·	·	use of voice input and output
·	·	·	·	·	·	use of nonvoice audio
·	·	·	·	·	·	use of light pen
·	·	·	·	·	·	use of ancillary materials
·	·	·	·	·	·	use of ______________

9. SOCIAL CHARACTERISTICS

present and negative	*not present*	*present and positive*	
_____	_____	_____	competition
_____	_____	_____	cooperation
_____	_____	_____	humanizing of computer
_____	_____	_____	moral issues or value judgments
_____	_____	_____	summary of student performance

1. The grade levels and ability levels for a particular program are primarily determined by the concepts involved. Other important factors are reading level, prerequisite skills, degree of student control, and intended instructional use. It is possible for a program to be flexible enough to be used across a wide range of grade levels and ability levels.

2. Some programs are designed for use by individuals. Others have been or can be modified for participation by two or three persons at a time. Simulations or demonstrations often pose opportunities for large-group interaction. A given program may be used in more than one grouping, depending on the instructor.

3. The time required for the use of a program will vary considerably. Include loading time for cassettes. A time range is the appropriate response here.

4. Instructional programs can be categorized according to their uses. Some programs may have more than one use, thus falling into more than one of the following categories:

Drill or practice. Assumes that the concept or skill has been taught previously.

Tutorial. Directs the full cycle of the instructional process; a dialogue between the student and the computer.

Simulation. Models selected, alterable aspects of an environment.

Instructional gaming. Involves random events and the pursuit of a winning strategy.

Problem solving. Uses general algorithms common to one or more problems.

Informational. Generates information (data).

5. These are factors relevant to the actual use of the program from the point of view of an instructor.

Flexibility. A program may allow the user or the instructor to adjust the program to different ability levels, degrees of difficulty, or concepts.

Intervention or assistance. A rating of "low" means considerable teacher intervention or assistance is required.

6. These are factors relevant to the actual use of the program from the point of view of a student.

Directions. The directions should be complete, readable, under the user's control (e.g., should not scroll off the screen until understood), and use appropriate examples.

Output. Program responses should be readable, understandable, and complete. If in response to student input, the output should be of an acceptable tone and consistent with the input request.

Screen formatting. The formats during a program run should not be distracting or cluttered. Labels and symbols should be meaningful within the given context.

External information. A program may require the user to have access to information other than that provided within it. This may include prerequisite content knowledge or knowledge of conventions used by the program designer as well as maps, books, models, and so on.

System errors. System errors result in the involuntary termination of the program.

Input. A program should ensure that a user knows when and in what form input is needed. It should avoid using characters with special meanings, restrict input locations to particular screen areas, and require minimal typing.

7. These are matters relevant to the subject matter content of the program.

Focus. The program topic should be clearly defined and of a scope that permits thorough treatment.

Significance. The instructional objectives of the program must be viewed as important by the instructor. Also, the program should represent a valid use of the computer's capabilities while improving the instructional process.

Soundness or validity. The concepts and terms employed should be correct, clear, and precise. Other important factors are the rate of presentation, degree of difficulty, and internal consistency.

Compatibility. The content, terminology, teaching style, and educational philosophy of the program should be consistent with those generally encountered by the student.

9. Competition, cooperation, and values are concerns that may be a function of the way a program expresses them. (War gaming and the "hangman" format are sample issues.) Also, the "humanizing" of the computer may serve for motivation or to reduce anxiety, but it also may become tedious, misleading, and counterproductive.

...mmary of student performance can be dichotomous (win or lose), statistical (time expended or percent of items correct), ... subjective (as in the evaluation of a simulation). It may be for student, teacher, or both.

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From "Guidelines for Evaluating Computerized Instructional Materials," by William P. Heck, Jerry Johnson, and Robert J. Kansky. Copyright 1981, by The National Council of Teachers of Mathematics, Inc.

APPENDIX

D. NORTHEAST USER GROUPS (PARTIAL LIST)

ACM Association for Computing Machinery (National Society of professionals with many SIGs including SIGCUE: Computer Uses in Education) New York.

Boston Computer Society/SIG: Education, PET Users, Northstar Users, Pascal/ Source/Micronet Users, Boston 80 (TRS-80), Apple Users, Monthly general meeting, bimonthly magazine, Boston Computer Update.

CERC (Computer Education Resource Coalition) Greater Boston education computing groups, regular meetings, calendar in Boston Computer Update, Cambridge, Massachusetts.

Digital Users Group, Woodmere, New York.

EDP/SIG
Roger Sullivan
Education Department
Commercial Union Assurance Companies
Boston, Massachusetts

Lesley College Educational Users Group. Library of microcomputer programs, books. Special meetings and annual conference. Cambridge, Massachusetts.

Long Island Computer Association. SIG: TRS-80, KIM, Software exchange, etc. Plainview, New York.

Microcomputer Resource Center, Columbia Teachers College, New York.

New England Computer Society. SIG: PET Users, Meetings, bulletin. Bedford, Massachusetts.

New England Apple Tree. Many teachers with school or personal Apple II. Lexington, Massachusetts.

New Hampshire A.C.E.S.
c/o Anne Knight
Computer Services
Stoke Hall
U. of N.H.
Durham, NH 03824

Regional Center for Educational Training, Computer Club, Hanover, New Hampshire.

Rochester Area Microcomputer Society (RAMS) SIG: Apple, TRS-80, S-100. Rochester, New York.

Rockland County Compucolor Users Group. Spring Valley, New York.

TERC (Technical Education Research Centers). Computer Resource Center, open house, national and regional workshops, program library, consulting.

TRS-80 Software Exchange. Milford, NH.

TRS-80 Business Club of Arlington. Arlington, Massachusetts.

Note: The Monroe C. Gutman Library of the Harvard Graduate School of Education puts out a directory which lists schools across the country that are using microcomputers. It is divided geographically. The sping 1981 addition is still in print, and an expanded revision is in preparation. Order the Microcomputer Directory: Applications in Educational Settings from the Gutman Library, Appian Way, Cambridge, MA 02138.

APPENDIX

E. SOFTWARE SUPPLIERS (PARTIAL LIST)

COMPress
P.O. Box 102
Wentworth, N.H. 03282
(603) 764-5831
Principally math, science, and statistical packages for colleges and high schools, Apple II, Bell & Howell.

CONDUIT
P.O. Box 388
Iowa City, IA 52244
(319) 353-5789
52 college and high school programs for Apple II, PET, or TRS-80.

Creative Computing
P.O. Box 789-M
Morristown, NJ 07960
(201) 540-0445; (800) 631-8112 (outside NJ)
Forty-seven software packages, including many from MECC and Huntington Computer Project. For Apple, Atari, and TRS-80.

Educational Courseware
3 Nappa Lane
Westport, CT 06880
(203) 227-1438
Apple Basic Tutor - science, history, and other subjects for junior and senior high.

Edutek Corp.
P.O. Box 11354
Palo Alto, CA 94306
(415) 325-9965
Drill and practice, elementary, Apple II.

J.L. Hammett Company, Inc.
Hammett Place
P.O. Box 545
Braintree, MA 02184
(617) 848-1000
Elementary/secondary programs for TRS-80, Apple, and PET.

Hayden Book Company, Inc.
50 Essex St.
Rochelle Park, NJ 7662
(201) 843-0550
Math programs.

High Technology Software Products Inc.
P.O. Box 14665
8001 N. Classen Blvd.
Oklahoma City, OK 73113
(405) 840-9900
Elementary software for Apple.

Houghton Mifflin Co.
One Beacon St.
Boston, MA 02107
(617) 725-5000
The Answer - instructional management package.

Instant Software
Peterborough, N.H. 03458
(603) 924-7296
Elementary math for Apple.

McGraw-Hill
1221 Ave. of the Americas
New York, NY 10020
(212) 997-6194
Gregg Division has computer literacy programs for Apple II using Pascal, that teaches problem solving. Webster Division is developing packages for TRS-80, including Tom Snyder's "Search" simulations.

Minnesota Educationl Computing Consortium (MECC)
2520 Broadway Dr.
Lauderdale, MN 55113
(612) 376-1118
All subjects K-12 for Apple.

Microphys Programs
2048 Ford St.
Brooklyn, NY 11229
(212) 646-0140
Programs in science, math, calculus, and language arts. Apple and PET.

Milliken Publishing Co.
1100 Research Blvd.
St. Louis, MO 63132
(314) 991-4220
Complete math sequence for Apple.

MUSE Software
330 N. Charles St.
Baltimore, MD 21201
(301) 659 7212
Elementary math for Apple, tutorials, and simulations.

Personal Software
1330 Bordeaux
Sunnyvale, CA 94086
(408) 745-7841
VisiCalc - accounting program for Apple, Atari, TRS-80.

Programma International, Inc.
2908 N. Naomi St.
Burbank, CA 91504
(213) 954-0240
Math, science for Apple, TRS-80, PET

Programs for Learning
P.O. Box 954
New Milford, CT 06776
(203) 355-3452
High school programs for Apple and TRS-80.

Queue
5 Chapel Hill Drive
Fairfield, CT 06432
(203) 372-6761
Educational Software for Apple, PET, TRS-80

Quality Educational Design (QED)
P.O. Box 12486
Portland, OR 97212
(503) 287-8137
Elementary math for TRS-80 and Apple.

Radio Shack Education Division
1600 One Tandy Center
Forth Worth, TX 76102
(817) 390-3832
Elementary/secondary math programs, language arts series for pre-school and early elementary.

SOFTSWAP
c/o Ann Lathrop, Library Coordinator
San Mateo County Office of Education
333 Main Street
Redwood City, CA 94063
(415) 364-5600 x4401
240 public-domain instructional programs for Apple, PET, Atari, TRS-80, and Compucolor, largely drill and practice. May be copied free by visitors or ordered by mail at $10 a disk. If you provide an original program on a disk, you get a disk free. Disks have 5-28 programs each, edited and evaluated, for one microcomputer system.

TYC Software
40 Stuyvesant Manor
Geneseo, NY 14454
(716) 243-3005
Earth science, language arts for TRS-80.

Unicom
297 Elmwood Ave.
Providence, RI 02907
(401) 467-5600 or (800) 556-2878
Language arts for Bell & Howell, Apple.

APPENDIX

F. SURVEY OF USE IN NEW YORK STATE CAPITAL DISTRICT

The following charts were prepared as part of a study of instructional uses of computers in the public schools undertaken by Nancy Willie, SUNY/ Albany, in conjunction with the Capital Area School Development Association. They are reproduced by permission. The report is dated August, 1981.

Table 6. **Percentage of Individual Respondents, by County, Who Use Computers in Various Pedagogic Categories**

	(A) Awareness	(B) Com Sci	(C) Programming	(D) Medium	(E) Manage	(F) Tool	(G) Other
ALB	68	32	73	55	5	9	23
COL	75	42	50	67	25	25	8
FUL	100	0	80	80	0	40	0
GRE	80	20	60	80	20	0	20
MON	80	20	80	0	0	20	0
REN	86	14	9	43	14	14	14
SAR	87	33	87	67	13	27	6
SCHE	60	60	90	70	20	50	0
SCHO	100	100	100	0	0	0	0
WAR	88	13	88	25	13	13	0
WAS	73	9	67	36	18	0	9
Region	78%	28%	76%	69%	13%	19%	10%

Table 7. **Percentage of Individual Respondents, by County, Who Use Computers in Various Content Areas**

	ALB	COL	FUL	GRE	MON	REN	SAR	SCHE	SCHO	WAR	WAS	Region
Maths	91	100	100	80	100	93	100	90	100	100	91	94%
Sciences	36	50	40	20	20	29	47	40	0	25	0	32%
Voc. Ed.	27	8	0	0	0	7	6	0	0	0	0	8%
Soc. Scis	4	25	40	0	0	14	6	30	0	12	0	12%
Humanities	0	8	20	0	0	0	0	6	0	0	0	2%
Languages	9	16	40	40	0	0	6	10	0	0	9	10%
Arts	5	8	0	0	0	0	0	10	0	0	0	2%
Writing	0	0	40	0	0	0	6	10	0	0	0	4%
Libraries	5	8	0	0	20	7	27	40	0	0	0	11%
Remedial	45	67	60	80	40	43	60	60	100	38	36	52%
Gifted	41	33	60	0	20	14	80	40	0	38	54	41%
Others	18	0	40	20	0	64	40	20	0	0	9	23%

Table 8. Percentage of Districts, by county, Who Use Computers at Each Grade Level Category (K-3, 4-5, 6-7, 8-9, 10-12)

	(A) K-3	(B) 4-5	(C) 6-7	(D) 8-9	(E) 10-12
ALB	33	55	67	67	100
COL	14	57	43	86	86
FUL	33	66	66	0	66
GRE	33	66	67	33	66
MON	0	25	50	100	100
REN	30	50	60	70	80
SAR	25	38	75	63	100
SCHE	50	75	75	75	100
SCHO	0	0	0	100	100
WAR	0	17	67	67	100
WAS	0	20	40	100	100
Region	22%	45%	60%	70%	92%

Table 9. Percentage of Districts, by county, in Which Students Access to Computers is by Selection, No Selection and Both.

	Select Only	No Selection	Both Policies Exist
ALB	78	0	22
COL	43	43	14
FUL	67	0	33
GRE	67	0	33
MON	75	0	25
REN	60	30	10
SAR	63	12	25
SCHE	75	25	0
SCHO	100	0	0
WAR	50	33	17
WAS	80	20	0
Region	65%	18%	17%

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Table 10. Percentage of Districts, by County, Who Have Before and After-School Use of Computers

	YES
ALB	100
COL	72
FUL	67
GRE	67
MON	50
REN	90
SAR	100
SCHE	100
SCHO	100
WAR	100
WAS	100
Region	88%

Table 11. Percentage of Individual Respondents, by county, Who Used Various Sources of Professional Development

	(A) Dist. In-Service	(B) BOCES	(C) Univer.	(D) Self & Network	(F) Others
ALB	59	23	50	77	14
COL	33	8	58	92	8
FUL	80	0	20	100	0
GRE	20	0	40	80	0
MON	20	0	80	60	0
REN	79	21	36	93	21
SAR	40	20	47	80	13
SCHE	60	0	60	80	10
SCHO	0	0	100	100	0
WAR	38	25	50	88	0
WAS	0	0	18	91	9
Region	45%	13%	45%	83%	10%

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Table 12. Percentage of Districts, by county, Using Various Computer Languages.

	(A) BASIC	(B) FORTRAN	(C) PASCAL	(D) PILOT	(E) OTHERS
ALB	100	33	22	0	0
COL	100	14	0	0	14
FUL	100	0	0	0	0
GRE	66	0	0	0	0
MON	100	25	0	0	0
REN	100	33	0	0	0
SAR	100	25	0	0	0
SCHE	100	50	100	25	25
SCHO	100	0	0	0	0
WAR	100	33	16	0	0
WAS	100	0	0	0	0
Region	98%	23%	12%	2%	5%

Table 13. Percentage of Individuals, by county, Who Use Computer Programs of Various Types

	(A) Drill & Practice	(B) Content Games	(C) Process Games	(D) Tutorials	(E) Simulations	(F) Analysis	(G) Others
ALB	82	50	59	41	45	14	9
COL	83	75	75	58	67	33	25
FUL	40	60	80	60	40	40	0
GRE	100	80	60	0	20	20	0
MON	100	60	80	0	0	20	0
REN	71	64	43	36	21	21	0
SAR	67	40	60	27	40	40	13
SCHE	70	40	80	50	30	20	0
SCHO	100	0	100	0	100	100	0
WAR	63	63	63	13	33	0	0
WAS	55	55	36	36	27	0	0
Region	73%	55%	61%	35%	37%	21%	6%

Table 15. **Percentage of Individuals, by county, Who Used Various Sources of Software**

	(A) Commercial	(B) Gov't	(C) Mags, books	(D) Networks	(E) Self	(F) Others
ALB	59	18	54	31	68	4
COL	75	25	75	58	92	0
FUL	80	0	20	0	40	0
GRE	80	0	20	0	40	0
MON	40	20	60	20	80	0
REN	71	0	57	29	93	0
SAR	80	0	46	33	80	6
SCHE	80	20	30	20	70	10
SCHO	0	0	100	100	100	0
WAR	75	0	75	25	75	0
WAS	64	0	45	0	54	0
Region	69%	12%	52%	27%	64%	2%

Table 17. Future needs ranking, by county. (Numbers in cells represent the "mean" rank of each need on a scale 1-5 where 1 is high need.)

	ALB	COL	FUL	GRE	MON	REN	SAR	SCHE	SCHO	WAR	WAS	Region
A. Staff Development	1.7	1.4	1.6	1.8	1.8	1.7	1.4	1.7	1.0	1.3	1.8	1.6
B. District Collaboration	2.8	3.2	2.0	2.8	3.2	2.9	2.5	2.8	5.0	3.1	2.1	2.7
C. Software Exchange	2.4	1.8	2.3	3.4	3.4	2.4	3.2	2.4	1.0	2.1	1.9	2.5
D. Hardware Demos and Service	3.7	3.5	3.0	4.0	3.6	3.5	3.4	3.3	5.0	3.1	3.5	3.5
E. Curriculum Development	1.9	1.4	2.2	2.3	2.0	2.4	1.9	2.3	2.0	2.0	1.3	2.0
F. Software Development	2.0	1.8	1.8	3.6	2.4	2.3	2.2	1.6	1.0	2.6	1.7	2.1
G. Administr. Support	2.6	3.5	4.5	4.0	2.6	2.9	2.9	2.3	2.0	4.0	4.0	3.0
H. Public Access Settings	4.5	4.4	3.3	3.5	3.6	4.2	3.9	4.1	4.0	3.8	4.8	4.1
I. Region/State Coordination	3.5	4.0	2.6	3.5	4.2	3.7	4.1	3.9	4.0	3.1	4.2	3.8
J. Funding	1.8	1.5	2.3	3.2	1.4	1.9	2.2	1.9	1.0	2.0	1.3	1.9
K. Teacher Centers	2.8	2.9	2.0	4.5	2.0	2.6	3.2	2.5	3.0	2.5	2.6	2.8
L. Others												

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