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Educating Teachers for the Information Age

Abstract

The educating of teachers for the information age has received some attention in the recent literature, but the emphases have been traditional, based on current conditions and forecasts. What is needed is a new view of computers in their roles as communications media and a need assessment approach to determining those roles which are appropriate in education. Given this context, it is possible to look at potential problem areas arising from computer applications in education. Courseware development, artificial intelligence, training of parents, teacher in-service, teacher workload, student motivation, and programming and writing are sample areas which are examined briefly. The conclusions are that we need to provide teachers with more relevant applications from which to learn about computers, make them more skeptical of claims about computer applications, and help them to be more sensitive to student needs in all areas, particularly that of computer use.

Introduction

Teachers will play, and are playing a crucial role in the implementation of computers into the curriculum. Educators must find effective ways of assisting teachers in this role, particularly in the area of teacher training. This paper is one contribution to the necessary discussion, presented in the hope that it will

stimulate the thinking of others who will respond with better ideas. Only through an exchange of ideas can we hope to make progress in making effective use of computers in education.

In talking with interested educators, I find that their views have a shaping effect on my own, resulting in a gradual evolution of my own ideas. Thus, although it often seems that I always write and say the same things, there is a change as a result of this interaction. During oral presentations, I usually begin with a set of cartoons on overheads. In addition to setting a more relaxed tone, they help to illustrate the changing roles which computers are creating. Since I now do much more of my own typing, thanks to the use of word processing, my secretary has had the time to draw the cartoons.

Another source of insight into the problem we face is provided by the poem "Antiquated", by Virginia Church, from the book with the implausible title, **Teachers are People** (Church, 1926).

Antiquated

Mr. Edison says
That the radio will supplant the teacher.
Already one may learn languages by means of Victrola records.
The moving picture will visualize
What the radio fails to get across.
Teachers will be relegated to the backwoods,
With fire horses,
And long-haired women;
Or, perhaps, shown in museums.
Education will become a matter
Of pressing the button.
Perhaps I can get a position at the switch-board.

This poem illustrates that many of our concerns about technology have been around for a good many years, since this book was published in 1926. Nevertheless, our concerns about technology, though not new, are still important.

Previously published material

In order to establish the foundation for a discussion of teacher training for the information age, it is worthwhile to examine some of the material which has been published on the topic. For the most part, this paper will discuss issues other than those in the previously published reports. However, it is useful to begin with these other reports and their contents.

It has been reported in a recent article that an Association for Computing Machinery (ACM) subcommittee has been looking

into the question of "what sort of computer education today's elementary and high school teachers need" (Rogers, Moursund, and Engel, 1984). The article presented a traditional analysis, based on current conditions and forecasts. I would like to argue that traditional methods are not sufficient. The skills they recommended for non-specialist teachers include "A familiarity with goals of computer use in education," "A knowledge of when and how it is appropriate to use computers in education," "A knowledge of the effects of computers on curriculum content and upon the processes of instruction and learning," and "A knowledge of current and future hardware, software, and computer-related educational materials." The committee recommended a two-stage approach for implementation, with all education students taking an introductory course, perhaps an existing computer science course, followed by an integration of instruction about the computer as a tool for teaching and learning into the existing courses.

There is also a recent article entitled "Computers and the future of education" (Berg and Bramble, 1983), in which the authors concluded with five suggestions, "Develop a commitment to life-long learning," "Analyze your own assumptions about education and teaching methods in the light of what you know about the future," "Become proficient in the area of computing which relates to your professional role," "Strive to implement an education program which goes far beyond teaching facts and concepts for the next standardized test," and "Be positive about yourself and your profession." It is interesting to note that only the third of these suggestions has any direct connection to computers.
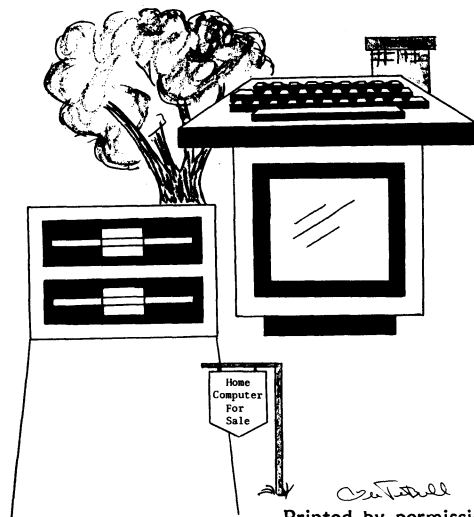
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Figure 1

Home computers have become very popular

Finally, in an article by Decker Walker (1983) in which he reflected on the educational potential and limitations of microcomputers, seven potential benefits of microcomputers are listed, followed by seven potential limitations of them. The benefits included "more active learning," "more varied sensory and conceptual modes," "learning with less mental drudgery," "learning nearer the speed of thought," "individually tailored learning," "more independent learning," and "better aids to abstraction."

Among the seven limitations mentioned by Walker, three points deserve special emphasis. First, he noted that the successful use of computer-assisted instruction (CAI) as a part of an ongoing class does not automatically mean that computer-based courses can support independent study, citing one study (the only one) which found disappointing results for bright students attempting independent study using CAI. Thus, the limitation is "supplement, not substitute." Walker's fifth point was an assertion that "Nobody yet understands how to use computers well for education." The most extensive and ambitious studies have looked at programs in which computers were used only 2-3 hours per week and the consequences of more extensive use are unknown. Finally, Walker listed a number of important problems which will not be solved (and may be aggravated) by computers. These included inequities in the quality of education, school budget problems, and the problems arising from divergent public expectations.

The points mentioned by Walker are closer to the theme of this article and some of them will be discussed later.

Computers as communications media

The use of computers as communications media has some implications for our ability to predict their ultimate use and their importance in our lives. Edward Lias, in his book **Future Mind,** described some of the principles of media, emphasizing the difficulty that people have had in predicting the ultimate uses of these media (Lias, 1982). To illustrate this point, he described an incident from 1876, when the then President of the United States, Rutherford B. Hayes, inaugurated a new long distance phone line between Washington and Philadelphia. Hayes was unfamiliar with telephones and ill at ease as he carried on a short conversation to officially open the service. After performing his duties, he stepped aside and said to an onlooker, "It's a very interesting invention, but why would anyone want to have one of them?" At about the same time, a British newspaper carried an article which commented on the increasing use of telephones in North America, but pointed out that they would never be that important in Britain, because "we have such an ample supply of messenger boys." In both cases, the emphasis was on the way things were currently being done, with no anticipation as to how the telephone

might change their ways of doing things.

The book **Forecasting the Telephone,** by Ithiel de Sola Pool, is a collection of predictions that have been made over the years about how telephones were going to be used (Pool, 1983). Many of them are quite accurate, but there is a set of them involving the phonograph, which are off the mark for both media. The phonograph was being developed to allow people to make long-distance telephone calls, since telephones in those days did not have enough power. The idea was that one would phone to a machine which would make a record to be played into another telephone, with this process repeated until the call had reached its destination, in a slower version of what microwave repeater stations do today. This cumbersome ritual seemed plausible to people of that day, since it compared favorably with alternatives such as the telegraph and the mail system (which was no better than it is today). Again, it was the comparison with the current way of doing things which led to this result.

If you have doubts about computers being communications media, a recent article (Latamore, 1984) in **High Technology** might help to convince you. In it, the director of electronic information programs at Link Resources was quoted as estimating that 90% of the use of consumer-oriented databases such as The Source, Compuserve, and Delphi is for communications (with other people). He said "It's very hard to make the consumer believe he needs (precreated databases) enough to pay for it. User-generated databases are a different story; people have a basic desire to communicate" (p. 18).

Since the future applications of computers are so difficult to anticipate and predict, we must be extremely flexible in our planning, allowing for continual modification. In addition, we will need constantly to seek input from computer users, in order to keep up to date on the changing applications of computers.

Needs assessment for computer usage

Assumptions. Due to the evolving nature of computer characteristics, needs assessment is a continuous process. However, the focus of the process must be on the curriculum (future, as well as current), not on the attributes of the technology. It may be that experience with computers will be more of a hindrance in determining these needs, since the experience will tend to bias our expectations. The outcome of the process should be in the form of software attributes, based on curriculum goals, independent (as much as possible) of hardware characteristics. (It should be noted that, in practice, this is very difficult to do. Hardware requirements must usually be set well in advance of the creation of software because the software must have hardware on which to be created. This can be a difficult

timing problem, since it is important to work with advanced hardware to develop new techniques, but one must not get too far ahead of the potential users.)

Curriculum Orientation. This includes what we do now, as well as what we would like to do. It is almost impossible to focus on the curriculum without any knowledge of computer potential, but worth trying. This phase might be followed with one which explicitly considers computer characteristics (this approach is similar in some ways to Scriven's "goal-free" evaluation approach). (Scriven, 1974).

Iterative. Any needs which are identified can only be tentative. Alterations will occur because of changing curriculum goals, technology advances, and the results of previous need-assessing cycles. The most important force in changing the needs will be the changing applications of the new technology. For example, word processing wouldn't have been an identified need a few years ago, but its use brings other needs into focus.

Process step 1. Initially we would focus on the needs that teachers, students, and others (parents, etc.) can identify in all curriculum areas, without directing their attention to the use of computers. As a follow-up, we would then ask the same groups to identify needs which seemed to be related to computer functions (possibly supplying them with some computer background in the interim). There is a trade-off between unbiased views from non-users and the more informed views of computer users. In either case, there is a danger that the "needs" will be based on intuition, which may not be supported in practice (such as touch screens, which seemed intuitively very desirable, but which, in practice, can be a negative factor due to arm fatigue).

Process step 2. After the lists of general and computer-specific needs have been created, the next task is to identify the "critical competitors" for satisfying those needs, paying particular attention to those which might be satisfied by computer applications. Critical competitor is a term used by Scriven in discussing product evaluation (Scriven, 1981). He stresses that a great deal of imagination may be required to identify critical competitors. He gives an example from an incident in Berkeley in which there were complaints about the time spent in waiting for the elevators on the main floor of a new building. There were no indicators on the main floor to show what floor the elevators were on and this seemed to make the delay longer. The solution of putting floor indicators on the main floor was too expensive, but the problem was solved effectively and inexpensively when someone proposed the critical competitor of installing full-length mirrors next to the elevators. When this was done, the problem vanished. (Scriven also stresses the need to consider printed materials as alternatives to computer-assisted instruction.)

Process step 3. From the lists of needs and critical competitors, the next task is to identify the computer functions which seem most appropriate for the various curriculum areas. It is possible that a major need might require more teacher time, which might be obtained through the use of computers for less important, but time consuming tasks. Therefore, appropriateness is not restricted to the highest priority needs.

Process step 4. At this point we would look for patterns among the needs, the critical competitors, and the computer functions. It may be that a particular computer function is a marginal solution to one need, but could be an optimal solution to a collection of needs. For example, even mundane applications can be useful in getting teachers started in using computers.

Specific areas of computer impact

Given the needs assessment context, we can consider a number of specific questions which might be brought to the attention of current and future teachers, as well as teacher trainers. These questions are not intended to be a complete listing, but are merely examples of the kinds of questions which should be addressed explicitly, but are rarely addressed at all.

Courseware development. The popular press seems to have most interest in the applications of computers which involve the delivery of content material via computer, such as computer-assisted instruction (CAI). However, the applications in the schools, and those being encouraged by the Ontario Ministry of Education in its recent software call, seem to be moving away from the content delivery applications. Even when the use of CAI is encouraged, the trend is definitely away from the creation of material by a single individual, therefore teachers should not be encouraged to develop material on their own. Another trend which should be brought to their attention is the increasing use of formative evaluation to improve the material before it gets to the ultimate users, rather than summative evaluation which only occurs after the product is finished. More emphasis on formative evaluation is the solution to the quality of software problems and a necessity in developing effective instructional materials of any sort.

Artificial intelligence. Along with CAI, the popular press is also enamored of Artificial Intelligence (AI). The source of their interest is the same in both cases - the fascination with the use of computers as a substitute for functions usually performed by humans (the use of robots also fascinates the press). Topics which fascinate the press are not necessarily unimportant, but may receive more emphasis than they deserve. Artificial Intelligence, like the concept of intelligence itself, suffers from an ambiguity of definition. Some have suggested that artificial

intelligence is restricted to those tasks which computers cannot do, for once the tasks are computerized, they merely become computer applications. It is probably more instructive to view AI as a continuum, ranging from the near mundane (which are not called AI after they are solved) to the exotic. The concern for education, however, is not with the definition (which could be "substituting computers for human mental process"), but with educational goals which might be achieved through the use of AI techniques.

The danger inherent in AI is that the selling of the concept is based on the exotic end of the continuum (and has been for twenty years), while the actual uses are in mundane ways. For example, an "expert system" to select drilling sites for oil exploration was created by a team of developers who studied an expert geological engineer for six months (similar work has been done in some areas of medical diagnosis). On the other hand, the study of expert chess players has not produced computer programs which play at their level, even though the study has gone on for decades. The difficulty is that those who predict the imminent and dominant use of AI seem to be basing their predictions on selected drilling sites, while others (of which I am one) feel that the magnitude of the problems for using AI in teaching is closer to that of chess. (Some of the CAI programs used in the CAN system, such as remedial mathematics, might be considered to be doing the work of an experienced teacher in their interpretation of diagnostic test results, but these programs do only a small part of the teacher's job and took years to develop.)

At the present time, it appears that AI may be another example of technology in search of an application. The question of AI use can also be considered on moral and ethical grounds, as well as the more pragmatic issues such as unemployment (which also has moral and ethical impacts). If we take our cue from the latter considerations, we would probably be more likely to emphasize AI applications which are used by students to work more effectively with subject matter (one might view a spreadsheet program, like VISIcalc as AI if it had not been invented), rather than attempting the more exotic task of replacing teacher functions in presenting educational content.

Training parents. Some school boards have started to offer training courses for parents. Although the provision of in-service training for teachers is still an unresolved problem for most boards, there are at least two reasons why they might want to divert some of their resources to the training of parents.
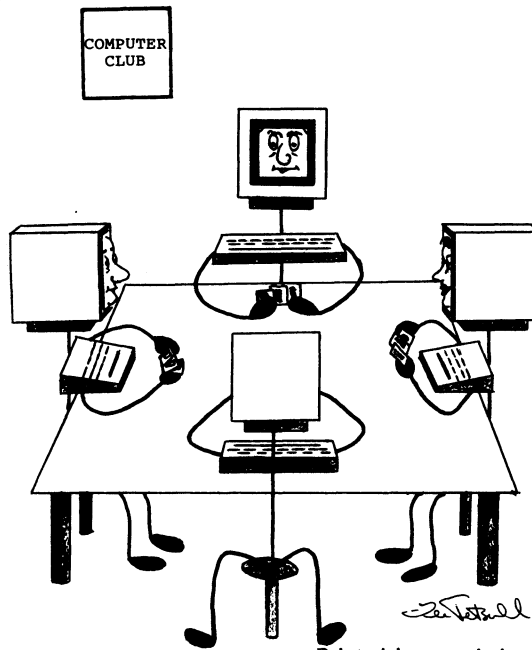
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Figure 2

Many schools have started "computer clubs"

The first reason is that commercially developed educational courseware will be (and is being) developed for parents, not for teachers or schools. The average school budget for instructional materials of any sort is approximately $15-20 per student, while those parents who have computers - a number that is steadily increasing - will spend considerably more, per child, on courseware. As a result, the advertising of courseware is already directed towards parents. If schools want the quality of courseware to be increased, it then becomes important to make parents into informed consumers, able to make the necessary discriminations between good and bad features of courseware.

The second reason for training parents, and the public at large, about the applications of computers in education is to prepare for the forthcoming call for evaluation of computers used in the schools. At the moment, in the eyes of the general public, it is sufficient that schools have computers and superfluous that they be doing anything useful with them. When this situation changes, (and with large amounts of dollars from restricted budgets being used for computers, and it is likely to be soon) it will be critical that the public have some notion of what it would mean to use computers effectively in a school setting.

An additional possible benefit is the steering effect that parents might have on teachers, particularly those who are reluctant to use computers due to non-pedagogical reasons. If the

parents' reasons for wanting computers are educationally sound, it may be more difficult for the teachers to resist, or more positively, it may be easier for the teachers to make use of computers in a useful way.

The contents of a training program for parents might include material on the evaluation of courseware, how courseware can be used, the use of tool programs such as word processing, and consideration of the ethical questions related to computer use, including software copyright. They might also stress the notion that computers carry their own cultural content, probably the major part of the rationale for the Quebec government's decision to subsidize a French-designed microcomputer in the Province's schools. The more important aspect of planning such a training program has to do with the staff and facilities to provide the program and this is a question which is extremely difficult to answer.

Teacher in-service. While speaking as a discussant at the 1983 AERA meetings in Montreal, Bob Davis spoke of "Nullification through partial assimilation" as a method by which schools avoid innovations (Davis, 1983). He meant that a school or teacher can adopt the most trivial aspects of the new technology, such as the architectural aspects of the "open plan", without the organizational or pedagogical changes. In implementing computers in the classroom, teachers may be looking for the most non-threatening and innocuous ways of introducing computers rather than uses which impact on teaching and learning (and hence require changes on the part of the teacher or curriculum).

The past years of computer in-service have provided instruction for the more enthusiastic teachers, those who were most eager to learn about and use computers. In the coming years, a growing proportion of the teachers will be unenthusiastic, possibly seeking training out of a sense of duty, fear, or both. As a result, the approach which worked with the previous groups may not be successful with future groups. In particular, it seems important that we clearly demonstrate to these less enthusiastic teachers that computers can be useful tools for them and their students. This means that the course should begin with the teachers being introduced to useful programs - programs which do something that the teachers want done.

It is important that teachers be introduced to application programs which address a specific need or application, rather than hear promises of programs which might exist or soon be created. One in-service teacher who surveyed the needs in a secondary school found that teachers were most interested in programs which helped them with their marks lists, followed by word processing and spreadsheet (such as VISIcalc, Lotus 1-2-3, or Multiplan) programs (Lang, 1984).

Teacher workload. We need to take a look at the relationship between the use of computers and teachers' workloads. Many of the people who promote the use of computers, myself included, have been leading teachers to believe that their workload would be reduced by computers, but this may not be the case. Certainly, with the computers that are currently available, the workload is probably increased. Most innovations impose an increased workload when teachers first begin to use them, but computers promise to increase students' ability to produce material, thus forecasting a permanent increase in teachers' work. This increase in the work load also seems to apply to the ICON, just being introduced in Ontario, which has the potential to help teachers, but whose potential is still largely unrealized.

Even when a teacher does not have to participate in introducing students to computers, or operating the computers, the work may increase. In a study of the use of word processing in Grade 5, one of my students (who had done most of the "overhead" work with the computers) was asked by the teacher if he could provide some assistance with marking the students' writing, since the quantity had increased, with the use of word processing (Hopper, 1984).

The obvious solutions to this type of problem involve various modes of decentralizing authority, such as peer review of written work, but this also creates new needs, in that the students may now need earlier training in critical reading and other skills. Other methods of sharing the workload include the use of students to generate instructional materials or to review educational software, but these also create new needs. The major stumbling block to these techniques is not the new needs, however, but the sharing of authority that they entail.

Student motivation. It is probably a mistake to think that computers **must** increase student motivation. The most obvious weakness in this assumption is the novelty effect. Many of us can remember when we were motivated to watch test patterns on television, even when the test patterns were dimmed by interference.

There are other motivational problems as well, particularly those of intrinsic motivation. In a recent interview, B.F. Skinner spoke against the tendency to attract students' interest with fancy graphics and other effects (Green, 1984). He believes that "when you refrain from jazzing up a program to give students false interests, you're actually letting them discover they can learn something" (p.24).

The Skinner stand seems to be supported by the conclusions listed in a recent article by Mark Morgan on "Reward-induced decrements and increments in intrinsic motivation" (Morgan, 1984). Morgan pointed out that there seems to be a consistent finding

that rewarding someone for participating in an activity decreases
their motivation to take part in the activity, while rewarding
them for their achievement in the activity increases their
motivation.   This can be interpreted to mean that if you reward
someone for studying mathematics, through fancy computer
graphics, they are less likely to study mathematics in the future,
while rewards based on their achievement in mathematics will
make it more likely that they will continue to study mathematics.

It may be that the current capability for computers to
motivate students (some students, at least) is misleading us into
believing that delivery of content via computer is an effective
application of computers, even when the content is poorly
presented.   In the long run, it may be much more effective to
concentrate on applications where the student creates and
manipulates the content, such as the creation of a database.
Another recent example of creative student input is in the use of
computers to control and modify the content of videodisks,
allowing students to relate their own indexes to the original
content, as well as add their own material in the form of
subtitles or overlays.   Such activities are themselves of great
value and should not be mistakenly assigned to a "motivating, but
not important" category.

Programming and writing.   One of the unfortunate failures
of the computer age has been the failure of those who teach
programming and those who teach writing to realize that the
skills they are teaching have a great deal in common, but this
situation may be changing (Ragsdale and McKelvey, 1985).
Recently, Schneider (1984) wrote on "Programs as essays" and
diagnosed the faults in some written prose in terms of the laws
of programming.   The reverse approach was used by English and
Edwards (1984) when they described "programming as a writing
activity" by applying writing techniques to programs.   This
approach can be traced back at least as far as Kernighan and
Plauger (1974), but the popularization of this view has only
occurred recently.

In addition to the links between programming and writing,
we must be concerned with the effects of electronic tools on our
writing skills.   It sometimes appears that electronic mail has a
definite effect on the way one writes, but this may be a function
of familiarity with the system and may disappear over time.   It
is probable, however, that as we are able to build more "writing
helps" into our word processors, these tools will have an impact
on our writing skills and styles.

In schools, the impact of programming tools, such as editors
which will not allow the user to write a program with a syntax
error in it, will certainly change the learning environment for
both teachers and students.   Much of the time and effort in
current programming courses is directed toward the elimination of

syntax errors and this affects the goals of students as well as the marking practices of teachers. Elimination of concern for the details of program syntax from the learning process, can allow more emphasis on the solution the student is trying to program. This can lead to more difficult marking for the teacher, raising such questions as "what is elegance?" in programming, and when the same effect is felt in writing, "what is style?" (The effect for English teachers may be similar to the effect that the use of calculators has had on math teachers.) The problem for the teacher is the already familiar one of attempting to separate the message (or algorithm in programming) from the style (or elegance), a difficult task, particularly if the message (algorithm) is considered wrong or incorrect. What the computer is doing is bringing this problem into sharper focus.

Along with these questions, there is also a question of appropriateness of computer use. Some people will say, apologetically, "I only use the computer for word processing", while my response to them is, "You have already found out what it took me almost twenty years to learn, that computers are great for word processing". Until we are free from the math-computer brainwashing, we will be limited in our effective use of computers.

Teachers and research. This is a time when it is especially difficult to define the variables which need research, since the variables change rapidly and we may not know the variables initially. The teacher can be the source of hypotheses, if we can find a way to gather these observations. The ability to observe the impact of computers on their users is an important part of the training for the information age.

Conclusion

The original question was, "How do we educate for the information age?" At this point, there appear to be three parts to the answer.

(1)   Give teachers knowledge about computers through their use of application programs relevant to them. That is, the teacher should not be asked to use a computer to accomplish (what seems to the teacher to be) an irrelevant task.

(2)   Educate teachers to be skeptical of the claims being made about the effects of computers and provide them with a few tools to help them in evaluating these claims. The stories which appear in the popular press are strongly biased toward extreme views, both positive and negative, since these create more reader interest, while the more

rationally compromised views are rarely published.

(3)   Help teachers to be more sensitive to the
       changing needs of students, particularly in the
       areas of computer use, but to maintain a
       sensitivity to all other areas as well.

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1984.

REFERENCES

Berg, P., and Bramble, W.J. (1983).   Computers and the future of education.   AEDS
       Journal, 17(1 and 2), 101-108.
Church, V. (1926).   Teachers are People.   Hollywood, CA: David Graham Fischer
       Corp.
Davis, R.B. (1983).   Discussant remarks in a symposium on education, technology,
       and social change at the Annual Meeting of the American Educational Research
       Association. Montreal, Quebec.
English, R., and Edwards, G. (1984).   Programming as a writing activity.   The
       Computing Teacher, 11(6), 46-47.
Green, J.O. (1984).   B.F. Skinner's technology of teaching.   Classroom Computer
       Learning, 4(7), 22-24; 28-29.
Hopper, C. (1984, April 17). Personal communication.
Kernighan, B.W., and Plauger, P.J. (1974).   The Elements of Programming Style.
       New York: McGraw-Hill.
Lang, D.R. (1984, May 31). Personal communication.
Latamore, G.B. (1984).   Services Link Home Computers.   High Technology, 4(4),
       18-19.
Lias, E.J. (1982).   Future Mind. Boston: Little, Brown.
Morgan, M. (1984).   Reward-induced decrements and increments in intrinsic
       motivation.   Review of Educational Research, 54(1), 5-30.
Pool, I. (1983).   Forecasting the Telephone: A Retrospective Technology Assessment.
       Norwood, NJ: Ablex.
Ragsdale, R.G., and McKelvey, B. (1985).   A possible future for teaching
       programming in Canada.   In M. Griffith and D. Tagg (Eds.), The Role of
       Programming in Teaching Informatics. pp. 43-49. Amsterdam: Elsevier Science
       Publishers.
Rogers, J.B., Moursund, D.G., and Engel, G.L. (1984).   Preparing precollege teachers
       for the computer age.   Communications of the ACM, 27(3), 195-200.
Schneider, B.R. Jr. (1984).   Programs as essays.   Datamation, 30(7), 162; 164; 166;
       168.
Scriven, M. (1974).   Pros and cons about goal-free evaluation.   In W.J. Popham (Ed.),
       Evaluation in Education, (pp. 34-67). Berkeley, CA: McCutchan.
Scriven, M. (1981).   Product evaluation.   In N.L. Smith (Ed.), New Techniques for
       Evaluation, (pp. 121-166). Beverly Hills, CA: Sage Publications.
Walker, D.F. (1983).   Reflections on the educational potential and limitations of
       microcomputers. Phi Delta Kappan, 65(2), 103-107.