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ABSTRACT

This paper provides an overview of the implications of microcomputer technology for education and of general strategies for integrating computers into schools. Allocation of 1 or 2 percent of a district's annual budget could bring computers within the reach of every student in a few years, and this will result in significant, far-reaching changes in education. Commercial applications of computer technology that are already causing fundamental changes in our society include robots, calculators, information storage and retrieval, "intelligent" wristwatches, cameras, and copy machines, and a proliferation of other applications. To make the best educational use of computers, teacher education is essential. Free evening courses and computer books and magazines in teachers' lounges are cheap ways to upgrade teachers' awareness of computers. A 3-level inservice model for teacher education in computers is proposed. Level 1 consists of workshops to provide teachers with basic hands-on experience; level 2 provides teachers with enough knowledge to bring students to the level of computer literacy aimed for in level 1; and level 3 consists of providing teachers with the broad knowledge of computer capabilities that they will need to fully integrate computers into the curriculum in a creative and useful manner. (TE)

MICROCOMPUTER APPLICATIONS IN EDUCATION: NOW TO NEXT DECADE

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Right now we are involved in a very massive change as far as education is concerned. If you like change, if you like to be involved in it, then you were born at the right time. On the other hand, if participating in massive change bothers you, then you're in for trouble. A Carnegie Commission Report, The Fourth Revolution, spoke about the four major revolutions in education: the first was the invention of reading and writing; the second was the concept that we would have schools and professional educators; the third was the invention of the printing press; and the fourth revolution is going on right now, the electronic revolution.

There's a division, a very superficial one in some ways, but a division between the world of education and the world outside of education. And part of what I'll talk about today is the world outside of education because it gives a very good indication of where we might be headed within the world of education. If the difference between what's outside of education and what's inside of education gets too large, then people outside of education react in various ways. They start private schools or they put in a new school board or they vote down school taxes.

Inside education, computers are starting to be available. In the United States the latest statistics suggest there's approximately one microcomputer for every 125 students. The ratio in California might be closer to one microcomputer per 100 students. Let's suppose that one microcomputer per 100 students was really used efficiently, what would that mean? If you schedule carefully, the average student might get four minutes of computer time a day--or if you're really super efficient, five minutes of computer time a day.

We're just barely beginning in this field, but let's look at what's apt to happen over the next four or five years. Let's suppose you're a relatively poor school district of $2,000 per student per year and for some reason you decided that computers and computer technology were important. Could you find one percent of your budget to put into that year after year? If you put up $20 per student per year and if you're willing to settle for medium quality microcomputer systems, one year's worth of money will give you a ratio of one machine per 50 students, which is probably twice the California average. And if you do that a second year, you will have a ratio of one per 25 students and if you keep doing that, it will lead you to a ratio of approximately one machine per 15 students--if you're willing to settle for that kind of machine. Of course your machines

start to wear out and you have to put up some money for maintenance and repair and so on. Whatever type of situation you're in right now, chances are you are nowhere near that fairly easily achievable goal of one machine per 15 students.

If you're a slightly wealthier district, maybe a $3,000 per student per year district, and you decide to put up one percent, how might you spend the $30? Well you might spend $5 per student per year on teacher training. You're probably already putting that much money into teacher training. It could be scheduled for computer inservice. And you also probably already have five dollars per student per year for books, films, and support materials. This could be used for computer books and support materials. The five dollars per student per year for software could be taken from the library funds. So it may be the case that to use $30 per student per year for computer education, you only need to find $15 per student per year that isn't already there.

The sense of direction of the cost of computing in education is that it very easily could reach the five percent level. Colleges and universities around the United States have started to gravitate toward the three percent solution or the four percent solution. A progressive school district may decide to go for the two percent solution. What could you do with a two percent solution? Well roughly speaking you can do twice as much as the one percent solution and after a number of years you might well end up with a ratio of approximately one machine for seven students, or 40 minutes per student per day on the machines. Now that starts to be enough to make a significant difference in education.

The point of this analysis is that it doesn't take huge amounts of money. It takes one percent of your budget or two percent of your budget or something akin to that to begin to generate enough hardware, software, support materials, and resource people. This is needed if computers are going to make any difference in education. So the question then becomes are computers going to make any difference in education? What are computers doing and what can they do?

I want to talk a little bit about the world outside of education and then I'll try to relate what's relevant to the business world to what's relevant to the education world. First, I'll give a few examples of commercial uses of the new technology.

Outside Education: Robots, Wristwatches and Laser Disks

An article talking about the production of robots in the United States says it will be a 250 million dollar business this year. Two hundred and fifty million dollars worth of robots. Robots costing in the range of $50,000 - $100,000 apiece. And each robot does the work of several human beings. A very crude rule of thumb would be one robot might do the work of three to four people but require one

person to maintain it. So three or four jobs go away and one job gets created. The job that gets created is quite different from the jobs that go away. Does this have any impact on education and what we're doing in education? It certainly scares some people.

We tend to think of a calculator as a simple minded thing--it adds, subtracts, multiplies and divides. But I bought a calculator that had a little printer on it and it had a built in calendar so you could punch in any year and month and it would print out a calendar for that month. Our educational system has coped with calculators quite well. Namely it has ignored them almost completely. Nearly every adult owns and uses a calculator and seems to think it's perfectly appropriate to do so. Somehow or other if you're an adult you have done whatever you were required to do in school in the area of learning to do arithmetic and now as an adult you can do what seems most practical to you. But our educational system continues to stress a system of rote memorization, of developing skill and machine-like operations which are done with paper and pencil like long division of multi-digit numbers, computation of square roots, or dividing fractions. Is there anybody here who has found the need to divide one fraction by another by hand sometime this week?

The wave of the future in terms of phonograph records is to have smaller records. There is a laser disk that stores music. This disk is somewhat less than five inches in diameter and holds about one hour of music. It has a capacity for six billion bits of information. Now I want to try to translate that into something. Six billion bits is a way to encode one billion characters in capital letters and digits. And one billion characters is the equivalent of one thousand 500 page novels. So we now have the technology to mass produce and sell cheaply a different medium for storing huge libraries. One little disk which maybe sells for $10 could include the entire Encyclopedia Britannica and other huge encyclopedias as well. A different way of storing and disseminating information is coming along, and that will affect education.

There is a wristwatch on the market that has a Spanish/English dictionary built in and also gives translations of 35 phrases from five different languages. There is also a wristwatch that speaks when you push a button, and a camera that tells you when you need to load the film or if it's too dark or you're out of focus. Now this wristwatch that can talk and the wristwatch that can store the dictionary and the camera that can talk are things which can be useful learning aids.

There is a commercial product from Xerox that has built-in computer-assisted instruction. When you turn on the machine, a computer automatically runs over 100 different checks on the circuitry to see whether all parts of the machinery are working right. And if you've got some kind of a complicated copying job, you push the button that starts the computer program running which teaches you how to do the copying job. This computerized instruc-

tional system saves enough service calls and enough training costs to be an economical way to proceed. In the past we have tended to think of computer assisted instruction first of all as something that is only going to go on in the school and second as too expensive, and this is a hint that both of those are wrong.

If you walk into a research library the librarian will say we probably have the answer to whatever you want to ask. The direction of information retrieval, which is a very major part of what education is about, is computerized information retrieval systems. There are literally hundreds and hundreds and hundreds of very large scale data banks now. In the business world it is very common to tie into these data banks. Education at the college-university level is also doing this, but education at the pre-college level has not yet faced this issue. As leaders in education it's something that you'll need to face--the nature of libraries in terms of retrieval of information is changing.

Inside Education: Hardware, Software and Teacher Training

What do you think a $795 computer will cost ten years from now or twenty years from now? It might be $50. Right now computers are in short supply in education, and our thinking about computers in education is inhibited by fears about their expense, their maintenance and the difficulty in learning to use them. If all those fears were resolved, the question would be what difference would computers make in education? One possible outcome of computers in education is that the schism between what goes on in the real world and what goes on in education will become broader and that even though every student has a computer, it won't affect the content and process of education. Another possibility is that education will become better and more relevant.

The heart of the matter over the long run is not going to be this hardware issue. This hardware issue is going to go away. Eventually if we need and can appropriately use one computer per child, we will have one computer per child.

A second part of the question is the kind of software available for use. About two years ago I heard it said that 95% of what's out there is no good. That means that five percent of the stuff that's out there is pretty good. And there are lots and lots of researchers trying to make better educational software. The most recent comment is that about 80 percent of the software is no good and about 20 percent is okay. So just in the last two years there's a tremendous change. So even though software is a major problem, the issue of software is going to get to be less and less of an issue or problem.

The third component is the teacher--the teacher's knowledge, skills, and attitude. No matter how many computers we get, no matter how good the software gets, quality education is going to depend on

quality teachers. Educators looking to the future will need to put money into hardware and software, but they will also need to put a lot of money into teacher education if they're going to have teachers who can take advantage of this hardware and software.

The one percent model that we looked at had the very modest $5 per student per year put into teacher education as a starting point. Well let me tell you how to blow that money and accomplish very little good. You take one of your teacher inservice days and you say one half of one day is the computer inservice and you bring in somebody like me to talk to all the teachers in your district for two hours. And then you try to have all the teachers in your district touch a machine for five or ten minutes or maybe look at a movie or something like that. What does it cost to have a teacher in a half day inservice? It's pretty easy to see that you could blow $100 per teacher on a half day inservice and that's what you'd accomplish with your teacher inservice money for one entire year. The question is as an administrator can you do something better with your money?

Here is where the clever administrator really stands out. What you want to do is to make significant progress on this teacher education problem without spending much money on it. What can you do with your $100 per teacher per year? Suppose that we don't use the time when the teacher is getting paid. We tell the teachers there's a free course they can take in the evening. Now compare the cost of that--no matter what you pay the instructor--to the cost of using the inservice time. Not all teachers will buy it, but some of them will and you'll save yourself a lot of money. You may then ask what can I do to entice teachers to come and take this free course? If you're putting computers in the schools, you might say that the people who attend workshops are the ones who get to have a computer in their classroom.

Each of you knows what you can do in your own building and in your own school district. And each of you knows how to bend the rules in order to get things done, and what we're asking is that you do them.

Another thing you can do with very little money is to set up a corner of the teachers' lounge with a few books and a few magazines.[1] Subscribe to half a dozen different computer publications and buy a few copies of Seymour Papert's book and just set them there. Maybe teachers will read them. Think about what it costs to buy one of these books or magazines relative to the cost of paying the teacher to read it. A variation on this idea is to give the teacher a list

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[1]The largest computers-in-education professional society is the International Council for Computers in Education, 1787 Agate Street, Eugene, Oregon 97403. It publishes The Computing Teacher and many booklets for teachers. Write for a free catalog.

of books and say, "If you will agree to read this book, I'll buy it for you." That's a very cheap form of teacher training.

What kind of person do you want to be the computer specialist in your elementary school or your secondary school? We may not have any choice right now since we're trying to get started. We take the teacher who's most interested, who gets started, who's self taught. But our goal is to have the same level of competence that we depend upon and require in every other discipline. And we have a long, long way to go, and we're not going to solve that problem by waiting for the colleges and universities to produce all these high quality people who are going to do it for you. If you want something reasonable to happen over the next five, ten, 15 years it's mainly going to come from inservice education. As principals and superintendents, leaders in education, you know how to do inservice education. You know how to have it happen, so take it upon yourself to do something about it.

Let me give you an idea of what you might be aiming at. Let's describe some levels of an inservice model for computer education. The goal of this inservice is that all teachers should become computer literate. When we start to translate that into some sort of processes, the first activity is usually some kind of a workshop. The workshop is not having a guest speaker to all of the teachers in your district at one time. It is four hours of very carefully taught hands-on experience where teachers look at various pieces of computer equipment, use different pieces of software, do a little bit of reading, and begin to get some feeling that they can learn to do the same things that their students are learning to do.

The second level in the inservice is for the teacher to know enough about computers to bring their students to level one (described in the above paragraph). Level one and level two are maybe the most you can expect for the average inservice program. But it's barely scratching the surface, and every district ought to provide higher levels of opportunities such as three-credit courses. What do you put in the first three-credit course for teachers? Level one and level two did not have computer programming. Level three has computer programming as one-third of its content. The purpose of the computer programming is not to produce someone to teach how to program computers. Teaching computer programming is just as difficult as teaching mathematics or teaching reading or any of the other disciplines. We would not tolerate people who had had one credit worth of reading or math being a reading teacher or a math teacher. So why do we tolerate people with that level of training being computer programming teachers? The purpose of level three is to give a broad general overview of many of the things that we're talking about today and to get teachers to start thinking about how computers as a tool are going to begin to change the overall content of the educational curriculum. We spent a lot of time teaching things that might not be so appropriate any more. What we're aiming at in the

computing field is to fully integrate computers into the curriculum in the same way that reading and writing is a tool in every discipline, that math is a tool in many disciplines and ought to be a tool in more disciplines.

The really big challenge is going to be to get teachers to the level where they can begin to deal with this technology in their curriculum and deal with changes in their curriculum that are dependent upon this technology. Having an overview of computers in education, learning to use a variety of software packages, learning to evaluate software, and developing some skill in using the word processor and information retrieval system turn out to be more useful than learning to program in BASIC. You can tell a high-quality teacher training course from a low-quality teacher training course almost entirely by whether it's mainly a computer programming course or mainly something else.

The information age is going to happen independent of what the school systems do. How well we succeed is a very good measure of the quality of our educational leaders. Much of what has gone on in computers in education so far has been individual teachers going out and learning on their own, often buying their own machine and using it in their own classroom. So if it's going to make some significant difference in education over the long run it's going to be because we have high quality leaders who will learn what they need to learn, and who will do what needs to be done.