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AUTHOR	Bowman, Barbara
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ABSTRACT

This paper suggests that many children from low-income and minority communities are not taught the skills and knowledge necessary to fully participate in the economic, social, and political life of the United States and that schools need to start early, to recognize the unique nature of how young children learn, and to design software that will ensure that all children have the same opportunity to participate in the technological world of the 21st century. These programs can be used in different ways and can be viewed as points on a continuum. At the most open end of the continuum is the software that reflects the thinking of the user. At the most closed end of the continuum are programs that set problems and determine correct answers. Programs that are the most open are the most important ones if we are to prepare children well for the 21st century. Young children can learn that technological skills are socially desirable and expected of them or conversely that such knowledge is exclusive and more available to some people than to others. Teachers must consider the effect of offering middle-class children opportunities to play with technology and use it as a resource for their thinking while providing few such chances for poor children. Similarly, technology can be used primarily as an individual and autonomous activity, or it can encourage cooperation through networking and collaborative activity. (LPP)

Equity and Young Children as Learners

Barbara Bowman

Abstract

This edited transcription of a presentation by Barbara Bowman, president of the Erikson Institute, discusses young children and computer technology. Many children from low-income and minority communities are not taught the skills and knowledge necessary to fully participate in the economic, social, and political life of the country. Schools need to start early, to recognize the unique nature of how young children learn, and to design programs that will ensure that all children have the same opportunity to participate in the technological world of the 21st century. These programs can be used in different ways and can be viewed as points on a continuum. At the most open end of the continuum is the software that reflects the thinking of the user. Moving along the continuum from open and active to closed and passive are computer applications that extend children's thinking by providing a structure with which to discover new ideas, new ways of thinking and reacting. Next are applications that provide information asked for by the user. Finally, at the most closed end of the continuum are programs that set problems and determine correct answers. Programs that are the most open are the most important ones if we are to prepare children well for the 21st century. Young children can learn that technological skills are socially desirable and expected of them or conversely that such knowledge is exclusive and more available to some people than to others. Teachers must consider the effect, for example, of offering middle-class children opportunities to play with technology and use it as a resource for their thinking while providing few such chances for poor children. Similarly, technology can be used primarily as an individual and autonomous activity, or it can encourage cooperation through networking and collaborative activity.

Introduction

The National Assessment of Educational Progress reported several years ago that more than half of the nation's 17-year-olds are inadequately prepared for jobs that require technical skills or to matriculate in college science courses. Many of these children are from low-income and minority communities, where they are not taught the skills and knowledge necessary to fully participate in the economic, social, and political life of the country. Chief among the reasons for this shortfall is that children have not learned to use technology creatively and competently. Clearly, the challenge to America's schools is to better prepare children to be competitive in the technology race ahead. I suggest that means schools must start early, recognize the unique nature of how young children learn, and design programs that will ensure that all children have the same opportunity to participate in the technological world of the 21st century.

The 1986 position statement of the National Association for the Education of Young Children (NAEYC) says, "Early childhood educators have a responsibility to critically examine the impact of technology on children and be prepared to use technology to benefit children." This is a very different position than most organizations and people had about computer technology for young children when I began to speak in 1978. Indeed, many of my colleagues worried that using technology would deny children the kind of authentic experience captured in blocks and paint. Or they believed that it was much too early to expose children to such complex machinery, and they would simply break it without getting anything useful from it. I am delighted that today teachers, administrators, parents of young children, and NAEYC recognize the importance of computer technology in the lives of all of us, children included.

Why Do We Teach Computer Technology to Young Children?

My first question that I'd like to discuss is: why do we spend time thinking about teaching computer technology to very young children? (And when I talk about young children, I mean children between 3 and 8.) Our world is full of computers, which children use every day. Children as young as 3 regularly use computerized toys, telephones, televisions, VCRs; and even though they usually do not know it, they see computers at work in cars, in adult work environments, at the check-out counter of the supermarket. And with the penchant that young children always show for the artifacts of their community, technology has quickly and easily been incorporated into the daily lives of most young American children—even more quickly than many adults. Young children accept these new technologies. We don't seem to need to spend very much time teaching them to use them.

Why then are we making all this fuss about teaching young children about computers? I think the answer to that question is that there are different ways to use computers, some of which require more preparation than others. For instance, sometimes we use applications that are already programmed into the computer, and the only thing we must learn is how to release the machine's capabilities. The check-out counter worker at the supermarket just has to learn how to rub the object across the computer screen in order for the cost to register. The young child only has to learn how to operate the joystick to get his truck to turn to the right or to the left. The child only needs to turn on the computer and load Math Rabbit for a series of problems to come up, the answers to which are already programmed into the computer. She only needs to match the letters of her name to those the teachers have programmed, and she will be rewarded with bells and whistles. These procedures are quite easily learned by most of us. (Except some of us like me who has to get my granddaughter to come and program my VCR!) The task is to learn the standardized set of procedures, follow them, and let technology do its thing.

Another way to use computers, however, is as a tool—a tool to solve personally interesting problems, a tool whose products we create, an instrument that reflects our unique thinking. This way of using computers may rely on routine actions by the computer as in a word-processing program where you press the A on the keyboard and the screen reflects an A. But the user has to take that A and all the other letters and notations on the keyboard and write something that makes meaning to other readers. The user must create, and the machine only reflects the user's creativity. Learning to use computers in this way is a far more difficult process than learning to turn on a drill-and-practice program such as Reader Rabbit. Although the content of Reader Rabbit may be challenging, if not always interesting, it offers little information about computers as tools.

When I started thinking and talking about computer technology and young children, the distinction between these two ways to use a computer was clearer. In those days, computer-assisted instruction was the primary mode for using computers with young children, and many of us dubbed those applications as electronic worksheets. The computer asks the question, and the child's answer was immediately graded as right or wrong. The other way was when children engaged the technology for their own interests. Logo was one such program, and although it was quite difficult for most young children, it did present an opportunity for children to instruct computers instead of the other way around.

Today, my former dichotomy has blurred, although I believe it's still relevant. Now I think about applications as falling on a continuum from active to passive, from hard-wired drill and practice to word processing and computer graphics, with several variations in between. My current way of thinking about computer applications is that there are at least four points on the continuum. At the most open end is the software that reflects the thinking of the user. The child controls the tool, telling it what to do to implement his or her design. Examples of this type of computer application include word-processing programs, calculators, and graphics programs that help children arrive at personal goals and objectives. This is the case when they use a calculator to solve an arithmetic problem or use a paint palette or a drawing program to make a picture. In these instances, a child must have a vision and understand the potential of the tool and be able to engage it to both stimulate and reflect on the mental task being performed.

Moving along the continuum from open and active to closed and passive are computer applications that extend children's thinking by providing a structure within which to discover new ideas, new ways of thinking and reacting. Examples of this type of software would be simulations, story boards, and games. The child is active and makes discoveries, but only within the constraints of the program. In other words, the programmer controls the possible visions. One example is the rainforest or the underwater programs that EduQuest puts out that involve a series of pictures in which the child can insert different plants and animals and insects and all kinds of different things. At the top, it has a bubble, and the child can also write a story. There are a number of different pictures, and the kind of story that the child might write can vary. The program gives the child some clues about what he or she might do. Obviously it constrains what the child can do, but she can make the animals bigger or smaller and she can make lots of insects or no insects. There's some vision involved, but the programmer has in essence cut down what it is the child has control over.

Next are applications that provide information asked for by the user. Examples for young children include encyclopedias, dictionaries, and the Internet. The content is programmed into the computer by someone else, but the individual can choose information he or she wishes to access and use it according to his or her own wishes. Southern Bell has an experimental program that I saw a year or two ago in which the child dictates the story and on the screen comes the written form of the story, which can be printed out. The child can immediately see his own words printed out in a story format. These kinds of programs have enormous advantages for children.

The President has been talking recently about having every child have access to the Internet. I can't resist telling you this story like a doting grandmother. I've got lots of grandmother stories, but one of my favorite grandmother stories is my 10-year-old granddaughter coming to me and saying she needed to write an essay on John Alden. Being a good teacher, I said, "Well, we have a couple of encyclopedias there, and we have the two on the computer. You should go read what they say and then come back and we'll talk about it." So she came back and she said, "You know, they don't even know when he was born. They have two different dates." It suddenly struck me very clearly—what are we doing to help children when they get on the Internet evaluate the information they are going to have? I felt like telling the President, "Wait a little while; we're not ready for every child to be on the Internet."

Finally, at the most closed end of the continuum are the programs that set problems and determine the correct answers. Examples of these applications are computer-assisted instruction, reading and arithmetic programs. These tutorials focus on the transfer skills, and although they can save teacher time, there is little evidence that they are in any way superior to a good teacher.

All of these types of computer use have value and should be part of the learning environment for young children. But I believe that those that are the most open—where the child can be most cognitively active—are the most important ones if we are to prepare them well for the 21st century. It is unfortunate that many schools focus more on closed-end tutorials than on the more flexible and child-directed programs. This is particularly unfortunate for children who do not have access to computers outside of school and are therefore deprived of the more intellectually challenging experiences available.

What Do Children Need to Learn about Computers?

My second question then is what is it children need to learn about computers? And I might say by implication, what do their teachers need to learn? First of all, we need procedural knowledge. Whether the task is dialing the telephone, starting and guiding a car, getting a picture on the television—we need to know some procedures. We need to know what to do to get it to work. As a society, we depend heavily on procedural instruction. It permeates how we teach and learn in western cultures because of the overwhelming number of skills that must be learned to operate in a complex environment. For example, most of us can describe the procedures necessary to engage our cars, but we haven't the faintest idea how the internal combustion engine works or how to make one.

Procedural knowledge is a step-by-step process: first you do this, then you do that, then you do the other, then you get your desired results. Much of what young children need to know about computers is procedural knowledge. How to turn it on, how to load the program, and how to respond to the stimuli on the screen are important skills. As I mentioned earlier, children learn these procedures incredibly quickly. They, as we, do not expect to understand why these pieces of equipment work and are satisfied just to use them.

But there are dangers if we rely only on procedural knowledge. Consider the number of children who do not understand the place value significance of 25 + 5. But they do know that if you add 5 and 5 you get 10, and if you put the zero down and take a little 1 and put it over the 2 and then add the 1 and 2 together, you will get the right answer. However, they do not understand that there is another set of 10 objects that is defining the place value of their number. Such children are limited in their ability to use arithmetic knowledge to develop new understanding of numbers.

So what is comparable understanding of computers for young children? What do we need to know about them if we want to help insure their technological education and not just their procedural knowledge of computers? There are some theoretical and philosophical positions that can guide how we conceptualize the role of technology in the education of young children. One is the developmental theories of Jean Piaget. Piaget emphasized the importance of young children developing schemata for the construction of relationships between objects and for symbolizing those relationships and symbols of those relationships through the child's own action and out of their current understanding of the problem. This suggests that young children need computer hardware and software that permit them to explore at their current levels of understanding to understand the symbolization potential of the system and that permit them to confront problems of interest to them.

Young children, however, often use ideas in the beginning with little understanding of the concepts being represented. For instance, what do you think a 3-year-old means when she says, "my grandmother went to Florida?" Certainly there is very little understanding of the space and time concepts that underlie her statement. The 3-year-old's understanding of "went to Florida" gradually extends through conversation and experience and comes to mean more than just going. As a general rule, when a 3-year-old says, "my grandmother went to Florida," and you say, "well what does that mean?," she means GONE, not another place in the south of the United States with warm weather or any of the other attributes that we might have on it. But using words helps children construct increasingly complex understanding of the concepts the words represent.

The same is true in using computers. Children may seem quite sophisticated in their understanding of a program, but usage in an open-ended program will deepen their knowledge. This is why I think it's so important to have computers in the classroom as well as in computer labs—so the children have a chance to use software and programs over and over, discovering new aspects with each use. For instance, the young child who creates a picture using a computer gains an increasingly complex understanding of the objects being represented in his drawing.

Another perspective draws on the theory of Lev Vygotsky and recognizes that all learning is socially embedded and that its meaning is drawn from how humans define it. Technology then is a social phenomenon as are all human inventions. And the meaning is drawn from and created by people.

Computers are not independent of social discourse but rather simply one of its forms. Children understand its meaning within the context of the values and beliefs of their communities. Because so much of a young child's basic development is unaffected by technology, it's easy to assume it is an unimportant add-on rather than a force shaping development itself. However, this is not the case. Just as differences in cultural practices and language lead to developmental differences, so too do the tools that people use. Literacy, for instance, has changed the way societies organize knowledge as opposed to how nonliterate societies do. Some observers point out that co-construction of knowledge possible through the use of computers in the international community has the potential of changing the framework of thought in all of our communities.

With computers, for instance, young children can enter new realms of experience. Computer networks provide a communication tool for connecting children to all sectors of society. They can communicate with their peers throughout the world and reach out to new teachers as diverse as those in arts and sciences. People—adults and older children—mediate children's knowledge and understanding, socializing in the interconventional representations of symbols. Responsive, reciprocal social relationships and patterns of communication motivate and structure a child's interaction with the objects in his environment. Even in the age of technology, it is through human relationships, relationships with others, through joint activities, through language, and through shared feeling with other human beings that young children grasp meaning. This speaks to the importance of the human mediators, the teachers, who either confer on computers the mantle of adventure, discovery, meaningfulness, and pleasure or that of drudgery and monotony.

How Do We Assure Equal Access to Technology?

How we structure access to technology then has implications for the structure of society as well as the knowledge of individuals. We must pay close attention to the opportunities different groups in our society have to use computers in various ways, and we must assure that access to technology does not exaggerate the already deep divisions in our society. Currently, this seems to be the case. If we look at the statistics on computer use in school, in 1993 we find that only 16% of African American preschoolers and kindergartners had access to a computer in school as compared to 26% of white children. Similarly, we find that 19% of children from households with low incomes have access to computers, while 33% of children from homes with incomes above $75,000 had access in their schools. And certainly the discrepancy between the computer access of the rich and the poor, between whites and minorities, has increased sharply since 1993.

What does it mean to low-income and minority children not to have experiences comparable to that of other children in their community? Not to have the opportunity for active computer use, for play with computers as tools? I suggest several things. First, they may not have the opportunity to deepen their knowledge about representing ideas with technological tools.

Second, and perhaps even more importantly, they may not think of themselves as technology tool users. Coming from homes that are less likely to have a computer and from families that often have little hope for their children's school achievement, they are doubly jeopardized when schools do not have computers or only use them for drill and practice. A number of years ago, we ran a computer program for children in a preschool center serving low-income African American and Hispanic families. One of our most startling findings was a sense of empowerment that program conveyed to parents. Their children were learning what other children were learning.

Third, children from low-income and minority communities may be further cut off from communication with the mainstream. Learning to communicate with computers is an increasingly important skill, and it is learned through participation. Just as young children need to participate in conversation to learn the ins and outs of oral language, they need to participate in computer talk to learn the ins and outs of this new form of communication. The present unequal distribution of computer technology deprives many children the opportunity to learn the skills and attitudes that underlie the use of technology as a tool and will relegate large numbers of them to the economic and social sidelines.

Given this background, what should we teach low-income and minority children about technology? Or more to the point, what do we want to teach children about technology so that we can attain the social outcomes we seek? I have a list of five recommendations that I think are important to think about in teaching young children about technology.

- *People control technology.* Children should learn that technology is controlled by someone—and that someone could be themselves. They should learn that technology is a tool for addressing personally relevant issues, rather than a medium over which they have no control. Supportive activities would include playing with open-ended computer programs, programs the child can control. In addition, children would take field trips to see how people use technology—people like themselves as well as people who are different.
- *Technology is not just computers.* Technology can take many different forms. Calculators, telephones, and tape recorders accomplish different tasks and operate in different ways. Young children can learn to appreciate these differences. Many of these objects are toys and can be integrated into the play areas of preschool classrooms. Or the real thing can be used in the work areas.
- *Technology has rules that control how it works.* While young children may not fully understand the rules that govern the various technologies,

they can begin to understand that there are such rules. Objects must have a source of power; they have plugs or batteries; computers must have instructions either built in or provided by the user. Children can learn the differences in the power sources and the ways different kinds of technology work. In our program, one of the things that we did was to bring in a video camera and let the children make video pictures and show them to their parents. They made up a story, they videotaped it themselves, and then they showed it on the television screen. One of the little boys said, "See, we're on television!" It was obviously the first time anyone in his family or anybody that he knew had ever been on television, and it was a very different kind of understanding of what is television than if all you see are other people on the screen.

- *Technology has languages.* Interacting with computers involves learning a vocabulary. Loading the disk, attaching the modem—these are the vocabularies the children can learn quite easily. Computer programs also have languages that permit the user to manipulate them. DOS tells you it's listening with a letter prompt, Mac has icons, Windows 95 says start, and Logo has a turtle. Children can easily learn to distinguish different programs, different computer types, and the languages that they use.
- *Computer programs require different ways of organizing thinking.* Some pre-programmed applications (Reader Rabbit, for example) require children to employ a narrow set of skills, matching and rhyming strategies, while more open-ended programs (paint programs, for example) permit a broad range of possible strategies and outcomes.

As I hope I've made clear, I think it's more important for schools or children outside of a mainstream of American experience to have this latter type of computer lesson, the kind of computer lessons that are broad and open and encourage children to think and plan and do for themselves. I have several examples that may help illustrate how computers can enhance or augment school learning for young children in ways not likely to occur without them. Clements, for instance, describes three 6-year-old children who work on a Logo program to construct a hat for a snowman. Motivated by the goal of creating the best snowman, their discussion and actions revolved about the relative size of the drawings produced by inserting various numbers in the program. Thus, their attention was focused on a critical set of relationships. The computer had created a visual reality between the hat and the numbers that neither alone could have done.

We had a similar experience in our computer program. Does anybody know Logo? Well it's a graphics program, and the children can make lines that go in different directions. One of our children discovered that if you punch in enough numbers, the line that you make goes across the screen and then comes back around and doubles and comes back around the screen. You can imagine how absolutely fun that was. The kids all were gathered around, and this little boy who discovered this phenomenon was showing everybody how to do it. One little boy said, "you mean that the higher the number goes the longer the line is?" That is not an understanding we expect from many 4-year-olds. They knew what it was they were doing. It made the learning far more significant than it would have been if we had tried to explain to them how if you make a line long enough it not only goes this way, it comes back around. Let me say that there were not many lessons in Logo that were as clearly beneficial to kids as that one was.

Changes in language usage have been reported as a consequence of computer activity. Researchers from the Erikson Institute reported changes in children's understanding of written communication after they joined a computer network with children from other states and countries. This was a computer network with nine different countries and four sites in the United States. All of the children spoke English or wrote English, so the communication was in English. Each site developed a newsletter to send to each other site. Since writing was the only tool these children had to communicate their ideas and report their findings, they had to think of their writing as different from writing for the teacher.

Children began to hone their writing skills because they had an audience that did not know much of what they took for granted. They would write an article, and then somebody in Finland would write back and say, "what do you mean the temperature was 95 degrees," since they only know about centigrade and it probably never gets to be 95 in Finland. So the kids are constantly having to figure out what might somebody not know about me in my writing. They had to seriously consider the background information necessary as they collected news and contributed messages to the network.

As children develop their abilities to understand and make use of simple systems, new opportunities occur for technology to affect learning. Computer technology obviously alters the possibility for enrichment and extension of basic concepts beyond what might be ordinarily available in the typical classroom. While it seems clear that computer technology can contribute positively to young children's learning, the more relevant question is under what circumstances will it contribute positively?

Computers do not act alone to affect children's learning. They act in concert with the competencies of the individual and with aspects of the social system in which they are embedded. They interface, for instance, with other symbol systems, within social contexts that include novices as well as those who are more expert in the domain, and they use historically elaborated techniques and strategies. The complexity of the interaction between the tool and its purpose and context makes simple claims of effectiveness suspect. Instead, computer appropriateness must be judged by the tasks to be accomplished, with whom it's to be accomplished, and what institutional setting and which conventions and traditions are going to be observed.

Before I conclude, I would like to say a few words about what computers are not good for. Because recent technological thinking has the appeal of innovation, it's important enough to fall victim to a pendulum swinging away from other forms of human thinking, such as relational, emotional, and certain forms of artistic thought. All are integral to nourish human development in children. Certain types of thinking are more consistent with technology than other forms. Linear and sequential organization of ideas, expression of its symbolic and abstract thought, and discrete categorical systems are among those most consistent with this new generation of educational technology. But while linear organization of experience provides rich opportunities to expand and create new knowledge and understanding, it's not the only way. Within the arts, for instance, there are many different ways of organizing and representing experiences. They are no less valuable because the idea is expressed by the person in singing or drawing or in movement. It's important for children to grasp the meaning of experience through their emotions, their sensory perception, and their bodies. Technological tools are one step removed from the personal.

Conclusion

Predictions of the educational needs of citizens in the 21st century stress the importance of flexible intelligence, rapid shifts in thinking as contexts differ, life-long ability to learn new ways of solving problems. The vision endorses teaching children to be active users of technology rather than simply reactors to it—a vision wherein technology is not simply putting the same old thing inside of a box rather than on a piece of paper or a slate, but a tool for their own thinking. Young children share their community's perceptions of the place of technological objects in the social world and the individual's relationship to them.

There's probably nothing inevitable about the way technology is integrated into the social fabric of our society. It has the potential for many different formulations. Young children can learn that technological skills are socially desirable and expected of them or conversely that such knowledge is exclusive and more available to some people than to others. In contemplating the social context of technology, teachers must be mindful that institutions tend to duplicate current power relationships among people. They must consider the effect, for example, of offering middle-class children opportunities to play with technology and use it as resources for their thinking while providing few such chances for poor children. Similarly, technology can be used primarily as an individual and autonomous activity, or it can encourage cooperation through networking and collaborative activity. Children may learn to view the world as a single truth or as a place for competing perspectives. Children may view computers for individual use or as instruments in joint problem solving. The choice is ours to offer.

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