Computer-Assisted Education May Not Enhance Learning

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The Child and the Machine: How Computers Put Our Children's Education at Risk. Beltsville, MD: Robins Lane Press, 2000.

Alison Armstrong and Charles Casement are coauthors of The Child and the Machine: How Computers Put Our Children's Education at Risk, *from which the following viewpoint was excerpted*.

> The idea that computers in the classroom enhance learning is so widely accepted that few people have questioned it. In reality, there is little evidence to show that computer-assisted education improves students' academic achievement. Research on the subject is ambiguous, and much of it is flawed because it uses standardized testing, which provides a very narrow measure of student achievement. Some research suggests that too much computer use can actually harm students' academic performance, and other studies show that computers in the classroom cause teachers to spend less time with students.

Parents naturally want the best possible education for their children. Just as the parents of baby boomers purchased home encyclopedias in record numbers, today's parents are buying computers and software to give their children what they believe to be a head start in their education. But whereas parents in the past might have waited until their children could read before purchasing home encyclopedias, today's parents are buying computers and software (known as lap ware) for their preschoolers, including babies as young as eight months old. Hoping to provide children with an advantage before formal schooling begins, parents are turning their toddlers into a generation of cybertots.

Like the encyclopedia salesmen, software marketing companies are targeting families with young children, and the market for home computers and learning software is growing even faster than the school market. In 1995, approximately 30 percent of U.S. homes had a personal computer. By 1999, this figure had risen to more than 50 percent. Parents want their children to have this magical tool whose use has become synonymous with academic success and marketable skills. They fear that without this vital piece of technology, their children will be left behind, ending up intellectually undernourished and almost certainly unemployed.

The exaggerated promises of computer advertising

Public perception of the computer as a passport to success has been heightened by the industry's relentless advertising. Advertisements designed to humanize the technology give computers friendly personalities and a desire to please. "You won't believe the things I do for this family," says an AST computer, which then describes how it helps "Junior," "Ms. Social Success," Mom, and Dad.

In another glossy magazine, a child cozied up with a computer is pronounced "the head of the class"—a favorite slogan in Apple's promotion of its technology. Apple and Microsoft also use television regularly to advertise the virtues and advantages of home computing, although the scenarios presented are sometimes less than

convincing. One Apple commercial shows a father and his young son apparently bonding while looking at the computer screen. At one point, the father smiles proudly and caresses the back of his son's head. Oblivious to his father's touch, the child is totally absorbed in the screen.

Behind the comforting assurance that computers are part of a close-knit family life is another, more urgent theme—children need computers because those who have them will outperform those who do not. At least, this is the assumption behind a number of computer hardware and software advertisements. Take, for example, a double-page advertisement for Microsoft's *Encarta* multimedia encyclopedia that appeared several years ago. "Forget Goldilocks and the Three Bears, tell us about Sartre," the headline reads. The ad continues: "'C'mon, dad, tell us about Sartre and existentialism and his belief in the inescapable responsibility of all individuals for their own decisions and his relationship with Simone de Beauvoir,' we pleaded as he tucked us in for the night." The ad shows the faces of two little girls who cannot be more than six years old.

Even less convincing is a Sears Brand Central ad showing a little girl standing behind a computer with her arms stretched above her head. "She may be only 5 but she's light-years ahead. By the time she reaches first grade, she'll have *traveled* to Jupiter and back." The computer monitor shows two planets in false proximity to each other. What help "traveling" to Jupiter will be to a first grader is left unexplained. The message conveyed by this advertising onslaught is that children with computers will outperform those without them. But do computers really enhance learning? Does consistent and convincing evidence exist to support this view?

What the research shows

Educators have been conducting research into the link between computers and improved academic performance for more than thirty years. In the past two decades, thousands of studies have been conducted in classrooms across the United States in an attempt to examine the effectiveness of computer-based instruction.

The evidence that emerges is inconclusive at best. Reviews of research published between 1985 and 1998 show mixed and sometimes contradictory results. For example, researchers at the Center for Research on Learning and Teaching at the University of Michigan analyzed the results of 254 controlled evaluation studies and concluded that computer-based instruction "usually produces positive effects on students." Specifically, their analysis showed that the average student in a class receiving computer-based instruction would outperform 62 percent of students in a class not using computers. On the other hand, a research team from Florida A&M University and Florida State University found a number of reviews that showed no significant difference in performance between students who were using computers and those who were not.

Results of several individual large-scale projects also do little to provide support for computer-based instruction. For example, the Minnesota Technology Demonstration Project, undertaken in the mid-1980s, involved more than 20 percent of the state's school districts. Researchers who studied computer-using fourth, fifth, and sixth graders over a two-year period discovered that, on average, these students did not perform as well in math, reading, and language arts as students taught by traditional methods.

Educators and parents must realize, too, that where the results were positive, not all students benefited equally. Generally, boys appeared to perform better than girls, and low-achieving students showed more improvement than average students.

Studies looking at the effects of integrated learning systems (ILSs) show similar, unconvincing, or at best, problematic results. In an ILS, a central management system links individual computers that are placed either in

a computer lab or in the library, or distributed among classrooms throughout the school. The system delivers courses as part of a school's standard curriculum. The subjects most commonly taught by this method are math, reading, and language arts. Students may spend thirty minutes a week or more working on practice drills presented on their computer screens, which are really just electronic workbooks. Newer applications have graphics and sound.

A frequently cited advantage of ILSs is that students work at their own pace. The system determines the level each student has reached in each subject and presents the lesson accordingly. The computer provides immediate feedback to the student and records the work. By monitoring the results, teachers are able to assess where their students are having difficulty and provide the necessary assistance.

At best, however, these systems have been only moderately successful in raising students' academic achievement. In some cases their effectiveness has simply been exaggerated. In an extensive review of ILS evaluation reports, Henry Jay Becker of the University of California at Irvine suggests that some studies (including the most widely cited) substantially overreport the effectiveness of ILSs. As well, only lower- and higher-achieving students appeared to benefit from using this technology. Students in the middle range (the majority) performed better when taught by their teachers.

Becker also cautions that evaluating the results of ILS programs is difficult because of the quality of the research. In a majority of studies, for example, poor evaluation design (which includes failure to compare students' performance with that of a control group receiving traditional instruction) is compounded by inadequate data collection, poor data analysis, inadequate description of how the program operated and the conditions in which it was used, or a combination of these.

One reason why ILSs do not achieve more impressive results is that they promote individualized problem solving at the expense of interaction with peers. Childhood learning is primarily a social activity, however, and children learn as much, if not more, through talking with their teachers and other students as they do by solving problems on their own. Where an ILS is in place, children have fewer opportunities for discussion not only with other children, but also with their teachers. Given that self-paced instruction is possible with an ILS, each child could conceivably work at a different rate on a different program. This means that little context would exist in which children could discuss their classroom work, and they would have fewer opportunities to share problem-solving strategies. Such systems make it difficult for teachers to focus class lessons and discussions.

Critic Douglas Noble views the growth in the use of ILS programs as a potential catastrophe. He believes that increased use of such systems "will almost certainly lead to more reliance on standardized testing to measure achievement," something for which an ILS is ideally suited. There will thus be a tendency "to reduce education to skills and facts pre-programmed into the computer, leaving little role for reflection, imagination, discovery, and creativity." This creates a kind of educational straitjacket in which "children are viewed as 'things' that are taught to perform specified tasks rather than as human beings to be cultivated." The fact that ILS programs appear to be effective only if used intensively seems to bear out his concerns.

With a growing pressure for accountability, the computer seems, at first glance, an ideal means of objectively measuring student achievement. It appears to be the perfect equalizer—one which does not play favorites. Yet not only does computer technology work better for some students than for others, but it also cannot accommodate the wide variety of learning styles evident in any classroom.

Problems with the research

Even where the use of computers appears to improve academic performance, we must approach the results with caution. First, most research studies take place over a relatively short period, often no more than three months. It is difficult to determine whether gains made in such a short time indicate a long-term trend or whether they merely reflect students' increased interest and motivation as a result of the attention lavished on them by the researchers and the novelty of using computers. When the novelty wears off, students' interest and performance may well return to previous levels.

In addition, the type of work that students do on computers is still mainly drill and practice and is not likely to interest them once the initial thrill of using a computer has dissipated. In spite of games and appealing graphics, once using a computer becomes routine, students find that they have no real control over what they are doing, and learning becomes dull and repetitive.

A Tennessee study discovered that students' attitudes toward computers changed the more they used them. Over a three-year period, students' enjoyment of the technology declined steadily, confirming that the novelty of using any technology plays a significant role in learning. In addition, the older students were generally less enthusiastic about computers than younger students, and the girls' responses were consistently more negative than the boys'.

The novelty effect is one reason why so many people believe that computers can motivate students and thereby improve their academic performance—motivation is a critical factor in determining how well children perform in school. The intensity with which children play video games makes many parents think that such enthusiasm will spill over into math, language, or science activities.

There is no proof, however, that such enthusiasm translates to other areas of learning. In a study involving six schools and 803 first and second graders, researchers at the Tokyo Institute of Technology studied the effectiveness of using computers to enhance creativity and motivation in primary school children. They found that the children who used computers appeared to have a more positive attitude toward the technology—a finding consistent with a number of North American studies. Computer use did not, however, encourage greater creativity or motivate the children to study more. What *did* motivate them were creative experiences such as reading books and saying rhymes.

In addition to the novelty effect, there is another reason for having reservations about the results of research studies; this concerns the role of teachers in implementing these studies. Students in experimental groups (those using computers) and those in control groups (not using computers) are often taught by different teachers, so that it is impossible to determine whether the teacher made the difference rather than the technology itself. If teachers enjoy working with computers and believe in their value as a learning tool, their enthusiasm is more likely to transfer to their students, at least in the short term.

Although some teachers get excited about using new computer-based materials and approaches, other ways of giving them fresh challenges certainly exist. Some schools, for instance, have discovered that when teachers attend workshops in the creative arts, their motivation and enthusiasm improve significantly. Computer technology is not the only way to reinvigorate a tired curriculum and listless students.

So why has there not been more public debate about the limitations of computer-based instruction? This is due, in part, to the selective nature of the information that is reported. Positive results receive more attention and are more likely to be published than negative ones. Companies that produce and market educational computer programs conduct and publicize the results of their own studies, which tend to place their products in a favorable

light. Discussion of research studies that are critical of computer-based instruction has only recently made its way into the mainstream media. The belief that computer technology will positively influence our childen's education is so widely held that few have questioned it.

Separating advertising copy from journalism is often difficult. Don Tapscott, author of *Growing Up Digital: The Rise of the Net Generation*, wrote:

> interactive software makes learning more fun for many children.... Early research indicates that the technology holds great promise—children appear to learn the three Rs more quickly and are more motivated to explore new subjects.

A recent television commercial for Patriot computers shows a pretty blonde teacher in an elementary school classroom demonstrating the latest software while proclaiming computers

> make learning fun as our kids perfect their reading, writing, and math skills. They can delve into the worlds of science, history, and geography, using interactive technology.... Ask yourself this: Do you want the best for your children?

Critical writing on the subject of computer technology began to emerge only in the past few years. One notable exception to the trend of media bias came from the *San Jose Mercury News*, a daily newspaper based in the heart of Silicon Valley. In 1995, the paper, led by journalist Christopher Schmitt, examined the link between academic achievement and computer technology to discover whether schools that had significant relationships with technology outperformed those that used computers to a lesser extent. In other words, was computer technology a significant factor in improving students' academic achievement?

The study examined the results of a 1994 statewide test, the California Learning Assessment Study (CLAS), in reading, writing, and mathematics. Taking each school's average in these subject areas, researchers tried to find a link between schools with high technology use and those with high averages.

The *Mercury News* did not find in favor of the technology:

> In general, the analysis showed no strong link between the presence of technology—or the use of technology in teaching—and superior achievement. The only exception was found in schools serving low-income students, where there was a stronger association between achievement and technology investment.

The significance of the *Mercury News* study, however, lies not just in its results, but also in the type of test that produced them. Despite being controversial (it has since been discontinued for political reasons), the CLAS was regarded as an improvement over other standardized tests in that it attempted to measure the quality of students' thinking and their achievement across the curriculum, rather than their ability merely to memorize facts, fill in the blanks, or select the correct answers to multiple-choice questions. By using the CLAS, the *Mercury News* study had at its core a much broader assessment of students' abilities than is normally used in studies that evaluate the effects of computer-based instruction.

Potential harms of computer-based education

More recent research in this field suggests that too much computer use in class can actually hurt students'

academic performance. A study undertaken by the New Jersey-based Educational Testing Service (ETS), which examined data from the 1996 National Assessment of Educational Progress (NAEP) in mathematics, found that frequent computer use in school tended to have a negative effect on the math scores of fourth and eighth graders. Students did not benefit from using computers more often, but from using them in particular ways.

For example, eighth-grade students who learned higher-order thinking skills through computer simulations—which allow students to examine the concept of velocity, for instance—had higher math scores than students who used drill-and-practice programs, which focus on lower-order thinking skills. Children can only benefit from such higher-level uses of technology, however, when they are developmentally ready to do so, and when their teachers are adequately trained.

Among fourth-grade students, frequent computer use at home had a negative impact on math scores. The opposite was true for eighth-grade students. This may be because older students were not playing video games or using low-level software at home; instead, they were using computers for word processing and research.

Black and low-income students had less access to home computers than white students and those from higher-income families. But the real inequality lay not with computer access, but with how well trained the teachers were in technology and how computers were used in class. Most troubling, said the study's author, Harold Wenglinsky, was the fact that black (and poor) children tend to use computers to learn basic arithmetic more often than white (and wealthier) children and that the programs they use are mainly for low-level exercises such as drill-and-practice programs. Their teachers are also less likely to have received training in the use of technology.

Inexperienced teachers who rely on computers in the elementary school years may be unwittingly abandoning their students because the makers of many software packages stress the fact that these will "free the teacher" to work with other students. This means that when students are occupied with the technology, they often receive little or no attention from their teacher.

Educational researchers Larry Miller and J. Dale Burnett have cast some light on this issue, suggesting that sometimes inexperienced teachers simply "set it and forget it," meaning that they set up students at a computer and then leave them to work alone. Not only do students sometimes miss out on enriching group activities such as story reading or discussion because they are preoccupied with the computer, but they also miss out on interaction with their teachers. "This observation was especially interesting," say Miller and Burnett,

> because it was different from their normal behavior where interactions with students were frequent. For example, when students engaged in seat work, these teachers would move from child to child, asking questions, clarifying problems, reteaching when necessary, and offering encouragement.

One teacher simply said, "The computer program is looking after their needs, and, besides, I get a printout of their performance."

The ETS study concludes that middle school students in grades seven and eight are more likely to benefit from using computer technology than children in elementary schools. This makes sense because regardless of how sophisticated the software program, it is simply no substitute for a teacher when a child needs answers to complex questions. As children grow older, they are more able to work independently and, because they now possess some basic skills, may derive greater benefits from using the computer for more sophisticated learning. Significantly, the ETS study found that private school students used computers less frequently than public school students in the fourth grade, but more frequently in the eighth grade.

It is difficult, if not impossible, to measure accurately the impact of computers on learning. This is not only because it is virtually impossible to separate the role of the technology versus that of the teacher, but also because of the nature of the achievement tests themselves.

The drawbacks of standardized testing

There are, in fact, well-documented limitations of the standardized tests that are generally used to assess the effects of computer-based instruction. The rationale of standardized tests is that they measure students' ability to perform well in school. But, to a large extent, the scores *determine* how well they will perform in school. What a test does is measure how well students are likely to do on subsequent tests of a similar nature. High test scores are not related to the depth or scope of students' learning, but merely to their test-taking abilities.

The origins of standardized testing go back to Sir Francis Galton, a cousin of Charles Darwin and creator of the infamous bell curve. In 1869, Galton published *Hereditary Genius*, a book in which he hypothesized that one could measure the degree to which people differed from one another in intelligence. He devised a way of representing the distribution of intelligence among a given population by constructing a curve, based on a purely imaginary scale, which showed that 50 percent of individuals would fall within the middle (normal) range, and the remainder would be divided equally among those of lesser or greater intelligence. The resulting curve was in the shape of a bell.

Galton assumed, then, that intelligence could be measured on a linear scale and that such measurement would result in a bell-curve distribution. These assumptions were based on no scientific proof whatsoever.

It is important to understand that standardized tests are designed to produce scores that conform to the bell curve. In other words, their level of difficulty is calibrated to ensure that half the students score above the norm and half below. Rather than assessing students fairly on skills and knowledge they might reasonably be expected to possess, the tests are constructed to create, as Herbert Kohl put it, "a hierarchy of success or failure." This is done in the name of an untested hypothesis that is supported by a completely arbitrary measurement of intelligence, a concept that, in many respects, still defies definition.

A standardized test provides a very narrow measure of a person's capabilities. Harvard University psychologist Howard Gardner has suggested that everyone possesses a number of intelligences, which contribute in varying degrees to each person's potential. In his book *Frames of Mind: The Theory of Multiple Intelligences*, Gardner differentiated among seven kinds of intelligence: logical-mathematical, linguistic, musical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal.

For example, writers are more likely to be strong in linguistic intelligence, athletes in bodily-kinesthetic intelligence, and visual artists and chess players in spatial intelligence. The traditional straight-A student demonstrates a high degree of logical-mathematical intelligence—the type of intelligence measured predominantly by standardized tests. By focusing on one type of intelligence, such tests ignore other forms of intelligence that can promote success later in life and, as a result, often fail to predict how well a child will do at the postsecondary school level or in the workplace. The fact that high test scores cannot necessarily be equated with later achievement lends support to the view that intelligence is multifaceted and cannot be measured by means of a simple test with "right" and "wrong" answers. Although current modes of intelligence testing appear to offer numerical precision, they are often conceptually flawed.

Just as disturbing is the fact that generations of researchers have discovered that standardized testing results in a narrowing of the curriculum. Where these tests are administered, teachers, and indeed whole school districts, begin to alter their curriculum in order to ensure that their students score high on the tests. But the teach-to-the-test approach has proven unwise. In such situations, students soon learn to be good test takers, but perhaps little else. As many critics have suggested, improved test scores do not necessarily mean that students are learning more. They may, in fact, be learning less. As teacher and writer William Hynes has said, "What produces good exam-taker is the opposite of what produces a citizen of literate habits."

In addition, most tests do not measure students' ability to analyze and solve problems and apply their skills and knowledge in other contexts. Indeed, without direct teacher involvement and evaluation, thinking skills are difficult both to teach and measure.

Software developers often claim that computer use in classrooms gives teachers more opportunities to be involved with their students on an individual basis, but direct teacher involvement can be better achieved by reducing class sizes rather than by putting children in front of computers. Smaller class sizes have a positive impact on children's academic performance. This is especially true of young children.

The 1984-1990 Student/Teacher Achievement Ratio (STAR) Project study out of Tennessee provides striking evidence. The study, involving more than 7,000 children, found that smaller class sizes allowed students more contact with their teacher and resulted in strong academic and social gains. Students also achieved consistently higher scores in their statewide tests. In fact, these gains continued throughout high school. Teachers reported a greater awareness of their students' family lives and had fewer discipline problems. Because teachers were able to give children more individual attention, they could identify children who had learning disabilities or who were having trouble with reading or arithmetic earlier, and these children received remedial instruction. And with fewer students in the classroom, teachers suffered less fatigue.

The cost to Tennessee, a traditionally poor state, was $1 billion. But the parents, teachers, and school administration believe the money is well spent. In 1988, elementary class sizes were cut virtually in half, and in 1989 the state legislated a fifteen-student cap on class sizes. Now seventeen other states have begun to follow Tennessee's lead. California, for example, launched a program to trim class sizes in the first through fourth grades, and in spite of difficulties in obtaining certified teachers and sufficient classroom space, teachers report high levels of satisfaction with the program. Perhaps if more school districts cut class sizes (and certainly this is a direction that early-childhood educators have urged for decades), school districts would have less reason to spend money on technology and more reason to focus on the relationship between student and teacher. Reducing class size also has another advantage: all students benefit equally.

Although the initial costs of reducing class sizes are high, school districts can find cost savings in other areas. Children who fail a grade in elementary school must repeat the grade, which costs the school system as well as the child. When class sizes are kept small, teachers can more quickly identify learning problems that are often undiagnosed in larger classes. When the system fails to identify a child with special needs when he or she is young, these problems become more difficult—and often more expensive—to fix later.

Learning out of context

One of the biggest problems with educational software that is designed to improve test scores is that it takes learning out of context. But children need a meaningful context for learning so that they can make connections between abstract knowledge and concrete experience. When children use educational software to enhance their

factual knowledge, they are expected to answer questions or solve problems with no other point of reference.

We find scant evidence that using such software results in smarter or more enthusiastic students. For example, a California study of fifth and sixth graders compared those who played *Where in the World Is Carmen Sandiego?* with students who drew maps and played noncomputer games involving the same geography facts. It found no significant differences between the groups in either their ability to recall facts or their attitudes toward the study of geography.

Where in the World Is Carmen Sandiego? is by far the best-selling educational software in North America. The game first appeared in the mid-1980s and has been followed by six sequels, three of which are also among the top five best-sellers. These programs use a detective game to teach geography and history. According to one review, teachers like the *Carmen* games because they send students scurrying to look up facts in reference books. (In the original versions of *Carmen Sandiego*, these consisted of *Fodor's USA Travel Guide* and *The World Almanac and Book of Facts*; later versions enable students to conduct searches on CD-ROM.) "The software," writes a *Home PC* reviewer,

> gives children a context for the geographical and historical information they uncover, so they tend to understand and retain it.... The idea is to keep children from being passive learners.

Thoughtful teachers, however, might have reservations about using a format that arbitrarily jumps all over the place, preferring, instead, an approach that allows children to explore a single topic from various angles and gives them time to absorb and fit together the details of what they are learning. While playing one of the *Carmen* sequels, *Where in Time Is Carmen Sandiego?*, we discovered that the game propelled us around the world on a whirlwind tour that never stopped long enough in any one place to show what was really going on. For example, during the game the following facts appeared on the screen, in this order:

- The founders of the unified Russian State were ruthless in the pursuit of their goals. Ivan the Terrible was notorious for the cruelty of his methods.
- Commercial dynasties such as the Medici family of Florence controlled much of the wealth and power in Renaissance Italy.
- Francisco Pizarro, a Spanish conquistador, sailed to Peru in the mid-1500s. There he ambushed the Incan ruler and forced him to pay a ransom of a room full of gold.
- Holland in the fifteenth and sixteenth centuries was first ruled by France and then by Spain. The Eighty Years' War ended Spanish rule and ushered in Dutch independence.

Such information is skimpy and sometimes misleading. On the last two items, minimal research revealed the following: Pizarro in fact made two voyages to Peru, the first in 1526 and the second, his voyage of conquest, in 1531, and the unnamed Incan ruler was Atahualpa; and the Eighty Years' War in fact ended in 1648, in the mid-seventeenth century. This kind of whistle-stop into-tour is of questionable educational value because the purpose of looking up information is to solve clues to Carmen's whereabouts rather than learn more about the times and places involved. Players cannot even do this at their leisure because they are given a limited amount of time (which can be varied according to a player's ability) to solve the mystery. The only context, and the only real point of the exercise, is to find out where Carmen is as quickly as possible.

The problem with games such as *Carmen Sandiego* is that they provide no framework into which students can fit the facts they learn. Instead, people and places pop up as isolated phenomena that are discarded as soon as they have served their purposes. To discover, for example, that "If that's the Eiffel Tower, Carmen must have gone to Paris" does little to teach children about the geography of France. Children are much more likely to

develop an understanding of geography if they are first taught to find their way around their own neighborhood, and then create their own maps of where they have walked and what they have seen.

While visiting an inner-city school in Boston, I noticed that during a geography lesson the teacher took several minutes to draw out of the students the name of the river (the Charles River) that flows through their city. Every student in the fourth grade would have known this fact, along with many other observations about the river, if they had simply been taken on a field trip to walk along its banks.

Our schools spend vast sums of money on the integration of technology, the effects of which are often counterproductive. Computer drills might help, in some cases, to raise students' standardized test scores, but such measures are a narrow form of assessment. Test scores, whether delivered electronically or not, do not even begin to hint at the potential in each child.

Further Readings

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