Young Children and Computers: Major Concerns and Potential Benefits

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Abstract

Computer opponents and advocates have made very different claims about how the effects computers have on young children. The goal of this paper is to review the major concerns and potential benefits of computerized learning by young children. Opponents believe that the computer has negative effects on children's physical and cognitive development. They also worry about gender issues and the safety issues with the Internet. This review balances these concerns with an overview of the existing research.

When the teacher plays an active role in facilitating children's computer use and selects developmentally appropriate software, then computer learning benefits young children tremendously. This review identifies potential benefits and discusses how the computer offers the features of play and is a resource to create a holistic learning environment, to access information, and to expand cultural awareness.

Key words: young children, the Internet, play, cultural awareness, holistic learning environment.

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Young Children and Computers: Major Concerns and Potential Benefits

If we examine the history of electronic technology in school classrooms, we find that the history is relatively short. Even the wave of innovation that began with personal computers is barely two decades old. During this time, there has been considerable debate regarding the developmental appropriateness of the use of computers by young children. Computer opponents and advocates have made very different claims about how the computer effects young children. In the early to mid 80's, the debate was at its height. Even though the debate is still going, it continues to a lesser degree today. The main goal of this paper is to review the major concerns and potential benefits of computerized learning by young children.

Major Concerns

This review identifies concerns about the use of computers by young children and balances these concerns with an overview of the existing research. The discussion is organized into several different topics. Opponents believe that the computer does not provide concrete experiences and is too abstract for young students to develop concrete understandings. They also think that the computer could isolate children and detract from children's physical and cognitive development. They also worry about gender issues and safety issues with the Internet.
Is the Computer Too Abstract?

The first common question early childhood educators would ask about the computer is: "Is their use developmentally appropriate for young children?" (Clements and Nastasi, 1992, p.188). Brady and Hill (1984) claimed that children must reach concrete operational stage before they are ready to work with computers. They meant that children should wait to the second- or third-grade age (around ages seven) in order to use computers. Many researchers, however, have found that preschoolers are more competent than has been thought. They can, under certain conditions, exhibit thinking traditionally considered "concrete" (Gelman & Baillargeon, 1983).

Clements, Nastasi and Swaminathan (1993) argued that "what is 'concrete' to the child may have more to do with what is meaningful and manipulable than with physical characteristics" (p. 56). They described a study that compared young children's reactions in two bean environments. One was a computer graphic felt board environment. In this computer program, children could construct bean stick pictures by selecting and arranging graphic beans, sticks, and number symbols. Another one was a real bean stick environment. Clements et al. (1993) stated that "the computer environment actually offered equal, and sometimes greater, control and flexibility to young children" (p. 56). They also concluded that "both environments were worthwhile, but one did not need to precede the other" (p. 56). Through the interaction with the computer, it is obvious that children can construct concrete knowledge.

A related concern is that the use of computers demands symbolic competence (Partridge, 1984). Sheingold (1986) argued that such a criticism ignored the fact that many activities young children naturally engage in are symbolic. They use gestures and language to communicate with people and employ symbols in their play. The use of computers might actually help children to understand the symbolic aspects of what they are learning by connecting the real world with
images on a computer screen. Sheingold used the example of preschoolers comparing a chicken egg incubating in a classroom with a computer simulation of the developing chick inside the egg. She believes that as children combine a variety of learning experiences, they may be able to reach a deeper understanding of their world. Therefore, young children might benefit from using appropriate computer programs along with rather than in place of more concrete "real" experiences.

Can the Computer Serve Children's Physical Development?

Few research studies have specifically focused on the impact of computer experiences on children's physical development. Some researchers contended that the computer involves the child's passive rather than active involvement, and that while sitting in front of a computer, children are not using large-muscle movements (Cuffaro, 1985; Hinitz, 1989). It has generally been noted that the fostering of fine motor skills and eye-hand coordination is a benefit derived from computer use (Goodwin, Goodwin & Garel, 1986; Hintz, 1989). Akamatsu and Sato (1994) proposed that devices such as the mouse provide the user with multi-sensory feedback that is visual and kinesthetic.

Some educators are concerned that using the standard keyboard is a problem for young children. A few studies, found that typing demanded a greater cognitive load for operation and consisted of a potentially confusing array of buttons making it less suitable for younger users (Alloway, 1994; Lin & Schmidt, 1993). Some researchers, however, found that typing offered a source of motivation and a sense of competence for many children (Lipinski, Nida, Shade, & Watson, 1986; Muller & Perlmutter, 1985). Studies showed that the mouse is one of the most easily manipulated input devices for young children (Lane and Ziviani, 1997). With advances of computer technology, the mouse has become a standard computer accessory. Most software for young children is now designed to be oper-
ate by using the mouse. Revelle & Strommen (1990) pointed out that children as young as three years are able to master the mouse. Thus, children feel more comfortable to use the computer.

Another concern is that the computer can not provide "hands on" experiences. Many educators consider it important to "give children a broad based - emotionally, intellectually, and in the five senses - before introducing something as technical and one-dimensional as a computer" (Oppenheimer, 1997, p. 53). Sherman (1998) questioned if "virtual manipulation will generate the same intellectual skills and sense of personal agency that come from physical manipulation (p.30)." Clifford Stoll (1995) in his book Silicon Snake Oil, " ... No computer can teach what a walk through a pine forest feels like. Sensation has no substitute (p. 213)." Such a concern seems to be based on the assumption that computer-based learning will replace more traditional learning experiences rather than being complementary to them. However, the computer is a tool to accomplish, or in some ways to support, teaching and learning rather than a tool to replace all the experience. Ross and Campbell (1983) found that microcomputers are compatible with Montessori instruction. Using computers could enhance such traditional Montessori objectives as freedom, structure and order, control and acceptance of error, meaningfulness of materials, and multi-sensory stimulation.

Does the Computer Isolate Children Socially?

Generally, early-childhood educators believe that the human and physical world holds greater learning potential than the computer (Oppenheimer, 1997). They are concerned that using the computer would cause young children to neglect their needs for experiences, which contribute to their social development (Watson, Nida & Shade, 1986; Barners and Hill, 1983). When children spend time using the computer, they would have fewer opportunities to develop their social skills. Moreover, the computer is a vehicle to pull children away from valuable play experiences (Barners and Hill, 1983).
Many research studies showed that these great concerns were unfounded (Fatouros, 1995). On the contrary, Research has confirmed that there are as many social interactions around the computer as in other activities (Lipinski, Nida, Shade & Watson, 1986; Clements and Nastasi, 1992). The computer area is rich with social interaction. Children are discussing when they are exploring a program together. They seek help from each other. Children as young as four-year-old can provide help through verbal instruction and demonstration (Clements et al., 1993). Children prefer working with one or two partners to working alone (Clements et al., 1993). Rhee and Bhargvari (1991) videotaped four-year-old children utilizing computers, and found that they spend 55 percent of their time with a peer, 25 percent of the time with a teacher and only 20 percent of their time alone. Clements (1994) report that the computer has even facilitated social interaction for children who were shy or just had not been able to find their "niche" in the group.

There are some disagreements about whether the computer facilitates interaction more than other activities (Fatouros, 1995; Clements, 1987). Muhlstein and Croft (1986) found that interaction occurred in a much higher percentage (96%) of cooperative play at the computer than at a range of other traditional preschool activities, such as blocks (27%), play-dough (14%), and art (8%). Their study showed that the computer was the only activity that resulted in high levels of both oral communication and cooperative play activity.

A few studies analyze not only the amount of talk occurring at the computer, but also the purpose and nature of this talk. Wright and Samaras (1986) observed preschoolers "thinking out loud" to solve a problem, with speech directed to themselves rather than to other people. This "private speech" is considered to be transitional between verbalized speech and internal thought (Berk, 1985). Borgh and Dickson (1986) report examples of preschoolers hypothesizing--wondering how the program worked, remembering what happened with specific key presses--and talking to the computer as if it were alive. From the findings stated above, using computers rarely isolates children. In fact, it
promotes social interactions and language development.

Can the Computer Enhance Children’s Cognitive Development?

Some educators question whether the computer can assist young children in developing cognition (Clements and Nastasi, 1992). The majority of studies report positive findings in relation to areas such as acquisition of basic mathematical concepts and skills, the development of spatial and relational concepts, creativity, decision making and problem solving (Clements et al., 1993; Clements and Nastasi, 1992; Goodwin, Goodwin & Garel, 1986).

Three-year-olds learned sorting from a computer task as easily as from a concrete doll task (Brinkley & Wastson, 1988). Studies have explored whether computer graphic programs have potential benefits for developing children’s spatial and geometric abilities. Clements and Nastasi (1992) reported Forman’s findings that certain graphic functions offered a new, dynamic way of drawing and exploring geometric concepts. A box function allowed children to draw rectangles by stretching an electronic "rubber band." The area fill function, which fills closed regions with color, "prompted children to reflect on topological features of closure as the consequence of actions, rather than merely a characteristic of static shapes (p. 227)." Carlson and White (1998) examined the effect of using a computer program to help kindergarten students understand the concepts of left and right. An experimental group of students used a selected program in addition to an instructional packet while a control group did not. They found that the computer program had a dramatic effect in helping students learn the concepts.

LOGO, a computer programming language developed by Seymour Papert, can help children elicit reflection on mathematics, decision making and problem solving. Several studies revealed that LOGO fosters higher order thinking for young children (Clements et al., 1993). Young children developed the ability to under-
stand the nature of problems and use representations such as drawings to solve them. In Kull’s (1986) study, a first-grade student wanted to turn the turtle to point into his rectangle. His teacher cued him when he wanted to turn a half of 90. After he typed "RT 45" (RIGHT 45), he realized that he went the wrong way and tried LEFT 90 without any assistance. His inverse operation produced his desired effect. Yelland (1995) observed young children using LOGO and found that children used a variety of problem-solving skills, such as planning, monitoring progress, responding to feedback, rectifying problems, and changing ineffective strategies. LOGO also develops children’s creative abilities. Clements (1991) reported that children draw more original art and score higher on verbal, as well as pictorial tests.

Is It Safe for Children to Surf on the Internet?

The Internet represents a radical change from stand-alone computers running computer programs such as The Oregon Trail or application such as word processors to a community of computers. The Internet makes the personal computer a more powerful tool for communication and broadens the educational community. However, many educators are concerned that the information on the Web is anarchic (Sherman, 1998; Lee, 1998). They worry that there is no way to protect children from "harmful" material. There is no easy answer for this complex issue.

In June 1997, the U.S. Supreme Court toppled the Communications Decency Act, ruling that the Internet is protected by the First Amendment. First Amendment defenders object to electronic censorship. They contend that only the parents may restrict their children from access to information on the Internet, and defend the rights of all Americans to roam the Internet or read any books they choose.

The influence of this ruling is international. All parents and educators are struggling between freedom of speech and protection of children. In order to
protect young children, some Taiwanese children websites develop their own search engine that excludes "harmful" materials (Min-Shin Daily News, Oct. 20, 1998). Parents were happy to see these search engines and expressed that they were more willing to surf on the Internet with their children. Since there is very little researches about the impact of the Web on children currently, the debate of safety on the Internet may expand and become even more complex as it impacts more international communities. I believe that we will see more and more research studies about this issue, and that educators and parents will find the answer of this concern soon.

Another concern is the issue of identity on the computer networks (Gray, 1993). On the Internet, people may "build a self by cycling through many selves" (Turkle, 1993, p.178). It is not surprising to hear how online chats allow a shy child to fulfill his or her social experience in ways that normal social life does not. Obviously, virtual communities offer a dramatic new context in which to think about human identity (Turkle, 1993). Some educators are concerned about how this experience effects a developing personality. There are some studies researching this issue among adults and adolescents. Regretfully, there are no reports discussing young children and identity in the age of the Internet. I hope that more researchers will explore this issue in more depth for young children.

Are Boys the Predominant Users of the Computer?

Many educators are concerned that computer use is typically viewed as a masculine activity (Wajcman, 1991). Since computers are quite often associated with math and science many people assume that boys are more interested in using the computer than girls (Hawkins, 1985). Studies about computer attitudes and computer use showed that boys have more access to computers at home and at school than girls do, display more positive attitudes to ward computer technology, and show a higher level of interest in computers than girls do (Martinez & Mead, 1988, Sutton, 1991).
However, studies indicate a trend toward equality in that gender differences in the use of and attitudes toward technology are not significant for kindergarten (Bergin, Ford, & Hess, 1993) and elementary-age children (Martinez & Mead, 1988; Lage, 1991). As to the amount of time young children spend at the computer and computer competence, there were no gender differences (William & Ogletree, 1992). Furthermore, boys viewed the computer as "masculine" and girls viewed it as "feminine". The same findings appeared in Yelland's (1995) interviews, an equal number of girls and boys responded that they are good at using computers and both gender groups perceived that each other as equally liking computers. Knezek, Miyashita, and Sakamoto (1996) found no strong gender differences among computer users at the first-grade to third-grade level in the United States, Japan and Mexico. Some studies even show that girls have more favorable attitudes toward computers than boys do (Plamondon, 1994), at least for certain tasks. Obviously, the computer is not just a tool for boys. Kaylyn, using the World Wide Web as a publishing tool, first created her KayNet when she was a 3rd-grade student. In her homepage (http://www.digitaljewel.com/kaynet/kay.html), she shared her Teddy Bear, stamp collections, and favorite links of animals, her friends' homepages, and some girl websites. I have visited her site several times since May 1997. To me, KayNet is a good example of girls demonstrating their computer competence.

The research findings of computer attitudes, computer use, and computer competence in the mid 80's were different from those in the 90's. The main reasons may be the popularity of computers in schools and at home. Girls now have more opportunities to use the computer. This result may also support the notion of William and Ogletree (1992) that early experiences with computers are important if positive attitudes towards computing are to develop. However, many researchers found that while girls and boys may begin school with similar interests in and aptitudes for computers, this changes as they develop (Bergin et al., 1993; Lage, 1991). As children move through the elementary grades into middle and high school, girls tend to show less interest in computers than boys do.
Thus, considering the traditional heavy dominance of computer use by males, researchers have recommended that the use of computers in the early years can facilitate gender equity and prevent gender bias from developing (Haugland & Wright, 1997; Clements and Nastasi, 1992). This recommendation supports females and girls creating websites. In the history of G.I.R.L., an international penpal club for girls ages 8-14, they claimed that "You'll be probably wondering why, why the club is for girls only. The idea of the club is to show boys that girls can do anything they can do!" (http://worldkids.net/girl/history.htm).

The Importance of Teachers and Software

The debate regarding the appropriateness of the use of personal computers by young children has lasted almost two decades. From the discussion above, computers obviously have the potential to support and extend children’s learning. When examining the effectiveness of using the computer, teachers and software are two key elements that we should not ignore. To a large degree, the teachers' choice of software creates different learning results.

Teachers and the social context determine what children acquire from computer experience (Samaras, 1996). Computers should be integrated into the curriculum and not merely used to entertain or occupy young children. However, most teachers in the early childhood classroom use computers for remediation or rewards (Hickey, 1993). In order to use computers successfully, teachers play a significant role in the process. Clements and Nastasi (1992) indicated that teachers can encourage and facilitate collaborative interactions within a computer environment in order to improve cognitive development. Samaras (1996) suggested that the teacher's role is to observe and evaluate the child's understanding of the task, to guide feedback, and praise the children's actions. Haugland & Wright (1997) analyzed six rules for teachers to play in young children's computer use to model the programs, to answer questions, to provide assistance when needed, to propose problems, to facilitate peer interaction, and to challenge
children to apply what they learned on the computer to new situations and projects. From Vygotskian perspective, the teacher provides support as the children develop novel, creative understandings and analyses during social interaction in order to aim their "zone of proximal development" (Vygotsky, 1978). If a teacher fails to play an active role, computer use will not be successful in facilitating children's learning.

There is often a considerable difference between the attitudes of children and those of teachers toward computers (Johnston, 1985; Smith, 1987). Smith (1987) found that in addition to being threatened by the changes computer create in the classroom, elementary school teachers were less confident than their students were. The critical reason was the teacher's level of computer knowledge (Keeler, 1996). Keeler (1996) found that after being given some intensive training, teachers changed their attitudes in a K-5 network project. Teacher became enthusiastic about their teaching and began to work together on the weekends in order to prepare and share computer program use. Obviously, it is important that teachers acquire more training to feel competent and confident in utilizing appropriate computer activities in their classroom.

Employing a variety of high-quality, age-appropriate software programs is one key to effective computer use (Hohmann, 1990). Roughly, there are two different categories of software for young children: drill-and-practice (nondevelopmental) and developmentally appropriate (Shade, 1994). The former is close-ended and focuses on the drill of low-level and abstract skills. Children must follow the curriculum designer's agenda to respond with yes or no answer. The latter is open-ended and exploratory, such as LOGO, problem-solving activities, simulations, and word processors. Children control the program, make decisions and solve problems through trial and error. Haugland (1992) assessed the effect of developmental and nondevelopmental software on children's cognition, creativity and self-esteem. He found that children using nondevelopmental software had significant losses in creativity. Children using open-ended software made significant gains in intelligence, nonverbal skills, structural knowledge, long-term
Potential Benefits

When the teacher plays an active role in facilitating children’s computer use and selects developmentally appropriate software, then computer learning benefit young children tremendously. Besides enhancing children’s social-emotional, cognitive, physical and language development, the computer offers the features of play. Using computers is also a resource to create a holistic learning environment, to access information, and to expand cultural awareness.

Linking the Features of Play

Generally speaking, children like the computer. Research studies have established that young children can work successfully with computer hardware and software and respond positively to the presence of the computer in their classroom (Shade, 1994). When they use computers, they feel that the computers are their playmates and also new toys for them. Genishi, McCollum, and Strand (1985) observed six kindergarten children using the program LOGO for three months and found that children often called the computer "you" or "he" instead of "it". In Young Children’s Computer Inventory Project (YCCI), a longitudinal study of childhood computing in schools, both U.S. and Japanese first- to third-graders who used computers reported enjoying computers more than those who did not use the computer (Knezek, Miyashit, Sakamoto, 1996). Children showed similar enjoyment in a network project (Keeler, 1996). Students chose to use their lunch and recess time for additional computer time.
These research findings are indicative of children's preference for the computer. By "playing" with the computer, they learn.

Play has been regarded as a unique vehicle for children's growth and learning. To early childhood educators, play is one of the most appropriate means of learning for young children (Porter, 1985). According to Piaget (1945/1962), play performs a major role in the child's growing mental abilities. For Vygotsky, play serves as a tool of the mind enabling children to master their own behavior (Vygotsky, 1966/1977). Vygotsky believed that play promotes cognitive, emotional, and social development. Various researchers have observed similarities between aspects of children's play and their interactions at the computer. Porter (1985) related six features of play to computer use:

* Intrinsic motivation: When children enjoy using computer software for its own sake, they may remain engaged in a computer-based learning experience for an extended period of time.

* Attention to means rather than ends: Children are likely to be more concerned with process rather than product when they are using computer software.

* Non-literal behavior: Pretend play may be inspired by computer simulation software.

* Freedom from external rules: Multimedia software allows children to set their own goals, make their own rules about what actions to take and decide when to stop.

* Self rather than object: Multimedia software allows children to be in a position of control.

* Active engagement: This is interdependent with the "self rather than object" and "intrinsic motivation" (desiring to do) features of play.

Porter made the point that the use of computers fits easily with traditional beliefs and practices in relation to play. There is a link between play and computers. Based on this premise, the use of computers can definitely increase opportunities for learning and development in physical, social/emotional, cognitive and language development.
Offering a Holistic Learning Environment

When children explore appropriate software or websites, they enter an integrated learning environment. Learning is not divided into separate or distinct subjects such as reading, writing, spelling, math, or science. Instead, children gain knowledge and skills inter-disciplinarily. Word processing is one example of the holistic learning environments that the computer can provide for young children. Word processing encourages children to experiment and communicate with written languages. When writing with a computer, young children can cooperatively plan and think about the topic, revise, and discuss spelling, punctuation, spacing, and text meaning and style (Clements and Nastasi, 1992; Clements et al., 1993). The same interpersonal interactions appear in writing e-mail. Third-grade students were applying writing and problem-solving skills in meaningful ways and not even realizing that they were doing so (Stuhlmann and Taylor, 1998).

Using LOGO also creates a holistic learning environment. Research confirmed that young children who use LOGO have shown significant gains in originality, divergent thinking, problem solving, fluency, the ability to link intuitive knowledge to concepts, collaborative writing, peer mediation, reflectiveness, and the ability to give accurate directions (Clements, 1991; Clements and Nastasi, 1992; Clements et al., 1993). Multimedia provides the same learning experiences. Haugland & Wright (1997) observed classroom interactions and reported that some multimedia programs such as Kids Work Deluxe or Storybook Maker, provide children with opportunities to compose stories and illustrate them with pictures they create.
Accessing to Information and Expanding Cultural Awareness

An abundance of instructional sites are available on the Internet as well as informational sites that make priceless masters found in a museum, the vivid images of an interactive encyclopedia, the latest information on the World Wide Web, available to teachers and young children. Papert (1993) calls computers the "knowledge machine. " Computers, he suggested, "places the power to know into the hands of a child " (Papert, 1994, p.93). Haugland and Wright (1997) described how a kindergarten teacher used the Internet to answer her student's question. Since the school did not have a library and few print resources to provide information on the development stage that a caterpillar lives after it turns into a butterfly, the teacher and her student posted a note to the Internet address of Dr. Science. Both the teacher and the student learned the answer from Dr. Science and experienced the power of the computer technology.

Computer-mediated communication can promote increased cultural awareness (Zellhofer, Collins, and Berge, 1998). Not only can students communicate directly with people all over the world, but they can research interesting topics about various countries, cultures, and natives. In this context, the Internet can serve as a powerful tool to transform the local classroom into a global classroom with students from around the globe interacting with each other first hand. The website of Miss Murphy's All Day Kindergarten Class, shares how children collected the weather information from all over the world by e-mail to work on their E-mail weather reports.

"One day we e-mailed to parents, grandparents, aunts, uncles, and friends all over the world. We asked them what their weather was like for that day. We discovered that weather is different all over the world."
Iowa was the coldest place we heard from. It was snowing there. Here in Arizona it was 71 degrees. We found out that parts of Texas had the same weather as we did. Arizona and Texas were the warmest places we got reports from. We heard from Washington, California, Colorado, Idaho, Iowa, Arizona, and even Budapest, Hungary. We made a weather chart and put in weather symbols to show what the weather was like from the places we heard from. We discovered that we received lots of weather information in one day! We learned a lot from this and plan to do it again in the spring.”

(http://www.tempe3.k12.az.us/Curry/murphy/weather.html).

Conclusions

After almost two decades of studies, researchers and educators are still asking if computers are appropriate for early childhood. Even though we need more findings to balance the concern about the Internet, the majority of studies indicate that carefully planned computer-based learning experiences have considerable potential to contribute not only to what young children learn but also to how they learn. The computer definitely serves as a cognitive support in the classroom.

Computer-based learning experiences can provide a context within which an adult can facilitate children’s learning of particular knowledge and skills, or alternatively to provide a meaningful context for peer interaction. The focus is not on the computer itself, but on the social context which is created through the use of computer technology. I agree with Papert (1993) that computers cannot revolutionize the way children are taught unless teachers examine how they teach without computers. Educators must examine their roles and strategies during computer instruction. If they still prefer drill-and-practice software and use computer activities as students’ rewards, it is highly probably that computer use will not be successful at facilitating children’s learning.
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幼童與電腦：憂慮？優勢？

方郁琳

摘要

對於兒童該不該學習電腦，長期以來爭議一直存在。對年齡較小的孩童，像是幼稚園到小學三年級這個年齡層，爭議更多。本文主要是針對這個較小的年齡層，探討美國相關文獻，並以主題歸類研究報告之發現。前半部份，針對反對者的擔憂，列出爭論議題，並舉證有關文獻平衡反對者的觀點。後半部份，則條列主要使用電腦之優點。

關鍵詞：幼兒、網際網路、遊戲、文化意識、整合學習。