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## Buried Treasure: The Impact of Computer Use on Young Children's Social, Cognitive, Language Development and Motivation

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Increasingly, young children are being exposed to computers at home and at school despite disagreement regarding the appropriateness and potential impact of technology on young children's development. Many views that predominant the debates lack empirical support and are too broad in their scope. This study examines the existing empirical studies from 1985-2004 on the impact of computer use on pre-schooler's social, cognitive, language development, and motivation. Findings are discussed within the framework of social and cognitive theories by Erikson, Piaget, and Vygotsky.

Today's computers provide individuals with a wealth of information, entertainment, and convenient services for a relatively small expense. They contain hundreds of news sources, and allow for personal communication, shopping, and bill paying. Computers run with more speed and ease of use than ever before, and they are improving all the time. Because of these advantages, the rate of computer ownership in U.S. households is increasing every year. According to the 2000 U.S. Census, 51% of American households own a computer (U.S. Department of Commerce [USDC], 2001). This

figure is up from 42% in 1998 and 8% in 1984. In 2000, 42% of all U.S. households had internet access, up from 26% in 1998 (USDC).

With this increase in computer ownership, young children have an increasing amount of exposure to this technology. According to the 2000 U.S. Census, 58% of children ages 3-5 live in a household with a computer present (USDC, 2001). This prevalence of computer access among young children is so common that in 1997 the Department of Education called for quantitative research in the area of technology for preschoolers (Fischer & Gillespie, 2003).

Despite many households having computers and internet access, there are still large gaps in ownership (“digital divide”) along racial, socioeconomic, and educational lines (Linebarger & Chernin, 2003; USDC, 2001). In 2000, 65% of Asian American households owned a computer, compared with 53% of Caucasians, 34% of Hispanics, and 33% of African Americans. According to the U.S. Census, 88% of households with an annual income of \$75,000 or more owned a computer, compared to just 23% of households with an annual income below \$15,000 (USDC). Similarly, 40% of individuals with a high school diploma have a computer; that figure is 76% for individuals with a bachelor’s degree or more. Research also notes differences in single versus married households, male-headed versus female-headed households, and rural versus urban areas (USDC; Wilson, Wallin, & Reiser, 2003).

These inequities have led parents and educators to look at schools to provide equal computer access and preschools are no exception to this (Becker, 2000). In the mid 1980s, 25% of preschools owned a computer and one decade later nearly every preschool owned at least one (Clements, 1999). Despite this increase of computers at home and at school, researchers and educators have consistently debated their appropriateness and usefulness in preschool classrooms.

### CRITICS OF EARLY COMPUTER USE

Central to the concerns of technology in preschools is the lack of social interaction envisioned by some. Stout (1983) was concerned that computers would turn children into miniature machines that completely lack in human

emotions. While more recent views are not so dramatic in their estimations, they do contend that a primary purpose of preschools is to provide social interaction and increase social competence (Lepper & Gurtner, 1989). Teachers and peers provide for a child's social and emotional well-being in ways that a computer cannot (Fein, Campbell, & Schwartz, 1987; Lepper & Gurtner).

Some researchers and educators are concerned that computers will be a way to entertain or manage large groups of children, and other teaching methods will be used less frequently (Lee & Houston, 1986). Similarly, concern exists that computers will be a distraction for children, who may choose computers over other appropriate learning experiences and physical activities (Cordes & Miller, 2000; Henniger, 1994). Others contend that computers are too abstract and hard for young children to use appropriately (Goodwin, Goodwin, Nansel, & Helm, 1986; Simon, 1985). Still others argue that young children should experience concrete learning activities through manipulatives and hands-on activities, not symbolic activities through computers (Fein, et al., 1987; Lee & Houston).

Elkind (1996) stated several other reasons why technology should not be introduced to young children. He was concerned by some educators' inclinations to measure a child's intelligence by their ability to manipulate a mouse and keyboard. Following his article, Elkind wrote a small note stating that a few months after writing this piece he was able to preview the National Association for the Education of Young Children (NAEYC) position statement on technology and young children and found that his concerns were being addressed and that there is no intention for computers to be the only tool used for young children to learn.

In 2000, a report was published by the Alliance for Childhood (Cordes & Miller, 2000) entitled, *Fool's Gold: A Critical Look at Computers in Childhood*. This report argued that technology is physically, socially, and intellectually detrimental for children. Their argument asserted that childhood should not be hurried and what is appropriate for adults is not always appropriate for children. They contended that computers pose serious health risks including repetitive stress injuries, eyestrain, and obesity. The reduction of human interaction will impact children's social and emotional development as well as their language development. Finally, *Fool's Gold* contended that while technology will change as children become working adults, the need for creativity and imagination will still be present.

## SUPPORTERS OF EARLY COMPUTER USE

The positions surrounding early technology use has not been all one-sided. After the *Fool's Gold* report was published, a lengthy response, entitled, *Strip Mining for Gold: Research and Policy in Educational Technology—A Response to Fool's Gold* was published by Clements and Sarama (2003). The authors discussed *Fool's Gold* lack of reliance on the hundreds of studies that have been published on this issue. They contended that it is not appropriate to lump all kinds of computer use together. Drill-and-practice, developmentally appropriate software, educational games, and drawing programs should be addressed separately, because their impact is different. *Fool's Gold* stated that computers cause social isolation, a concern cited by many professionals. *Strip Mining for Gold*, however, stated that no research has found this to be true, and instead, research supports the notion that computers “serve as catalysts for positive social interaction” (Clements & Sarama, 2003, p. 4).

Critics assert that children should have access to concrete learning materials, a criteria that critics say excludes computers, because computers cannot physically be handled and manipulated. However, this notion of what is a concrete learning experience is challenged by some authors (Clements, Nastasi, & Swaminathan, 1993). They argue that concrete actually refers to what is meaningful and manipulatable, more than physical characteristics. One study compared children using a computer felt board with children using a physical felt board (Clements & Nastasi, 1992). It was concluded that both experiences were similar and that the computer felt board offered more flexibility and options than the physical felt board.

Some argue that given the presence of computers in our everyday lives, we should start early in our use of technology (Lee & Houston, 1986). They assert that young children have the motivation and fearlessness to explore computers. Computers increase a child's independence and sense of control over their learning, which increases motivation and self-esteem (Ainsa, 1989; Burg, 1984; Clements & Swaminathan, 1995; Lee & Houston, 1987).

Supporters of early use of technology agree with the critics that technology cannot exist in a vacuum and should not be the only learning tool in a preschool classroom (Kosakowski, 1998; NAEYC Position Statement, 1996). Children benefit from a variety of learning experiences, including both physically concrete and meaningfully concrete. Many advocate for

computers to be considered another learning tool for children to use in exploring their world and engaging their five senses (Hohmann, 1994; Shade, Nida, Lipinski, & Watson, 1986).

Others believe that computers contribute to more effective thinking, problem solving, and learning (Haugland & Wright, 1997; Papert, 1980). Computers are inherently interactive and require active participation (Lepper & Gurtner, 1989). Some say that computers help children become more fluent in symbols, including pictures, gestures, and words (Wright, 1994).

While the ongoing debates and discussions have advanced our understanding in this area, there are a number of limitations in the existing literature. For example, some views have relied very little on empirical data. In many cases, assertions of the benefits or detriments of computers are made with only a theoretical or philosophical foundation. Some arguments are too broad in their scope and they neglect to focus on specific developmental stages or domain areas. Similarly, computers may have one type of effect on one developmental domain and a very different effect on another developmental domain. In order for valid and informative conclusions to be made, there is the need for a comprehensive review of the empirical studies to examine the potential impact of computer use on specific age groups across multiple developmental domains. This current review proposes to accomplish this goal.

Articles that met certain inclusion criteria (e.g., empirical studies that examined children ages 3-5 in selected domains) were included in this review. Literature searches were conducted through PsychInfo and ERIC databases from 1985-2004 using individual or combinations of keywords such as “computer use,” “technology use,” “young children,” and “pre-school.” Four developmental domains (i.e., social, cognitive, language, and motivation) were chosen for this review based on NAEYC’s criteria for developmentally appropriate practice with preschool children (Bredenkamp & Copple, 1997). NAEYC states that physical, social, cognitive and language development are important domains for early childhood educators to consider when developing programs for young children. Because the literature regarding computer use and physical development focuses primarily on school aged children and adolescents, that area will not be discussed in this exploration. Motivation was included in this review as a developmental domain because it is considered an essential component of learning (Lepper, 1985).

## IMPACT OF EARLY COMPUTER USE ON SOCIO-EMOTIONAL DEVELOPMENT

Eric Erikson (1963, 1982) described the task of 4 and 5-year-old children to be initiative versus guilt. Young children should be permitted to explore a variety of learning materials and experience a variety of activities. Children should have a sense of direction and purpose in their activities, and not made to feel guilty about these goals.

Gillespie and Beisser (2001) described how Erikson's theory of psychosocial development has implications for early technology use. Appropriate software provides children with a wealth of choices that can be freely explored and manipulated. Open-ended software programs allow children to make decisions and take initiative in their learning. Finally, it is important for teachers to encourage children's exploration of computers and other learning materials and not stifle the choices they make.

Through incorporating many choices and encouraging children's exploration, children will gain a sense of initiative and increase their self-esteem (Haugland, 1992). In one study, young children with computer access had more significant gains in self-esteem than children without computer access (Haugland, 1992). In addition to increasing children's initiative and self-esteem, computers can serve an important function of enhancing children's self-concept (Haugland, 1996).

### Socialization

Adults typically use computers as a solitary activity. Many adults go to work and sit in front of a computer screen and engage in little or no direct human interaction for much of the day. This issue is of primary concern for many parents and teachers. It is often feared that computers will isolate children and deprive them of the socialization that is so important at this age.

Active peer interactions were found in one study of 14 preschool children (Heft & Swaminathan, 2002). These interactions included: children

observing and acknowledging each other, children commenting and being ignored, and children sharing the computer or helping each other. In addition, 18 peer conflicts were noted, most occurred regarding turn-taking and sharing of the computer. The authors stated that there were only two computers in the classroom, which contributed to much of the conflict. Numerous teacher-child interactions were also recorded (Heft & Swaminathan). Examples of teacher-child interactions included: teacher talking about what child was doing, teacher intervening in rough or disruptive computer play, and the child asking for the teacher's help. The authors concluded that children exhibit a large diversity of social interactions while at the computer with both peers and teachers.

Shahrimin and Butterworth (2002) found similar positive and negative interaction patterns among peers playing at the computer in their sample of six 5-year-old children. The most frequently coded interaction patterns were directing partner's actions, providing information, asking for information/explanation, self-monitoring/repetition, declarative planning, disagreeing with partner, and showing pleasure (Shahrimin & Butterworth). The authors concluded that even with little or no teacher guidance, the 5-year-old children were able to interact in a variety of ways with peers while on the computer.

Even when the computer area has a teacher-imposed "one child per computer" rule, numerous peer interactions occur, as in one study by Freeman and Somerindyke (2001). After this rule was dropped, peer interactions were observed and three categories of children's social play were formed: active navigators, vicarious navigators/super-on-lookers, and spectators. Active navigators were the children who appeared to be child "experts" at using the computer. Five "experts" were identified in the present sample, and all had computer access at home. vicarious navigators/super-on-lookers were children that showed an interest in the computer, but never claimed control of the computer nor acted as a resource to other students about the computer. Finally, the spectator group of children was the children who showed a slight interest and curiosity about the computer, but were the least actively involved with the computer.

In a study of 95 kindergartners, children exhibited appropriate amounts of cooperation and turn-taking while on the computer and only two aggressive behaviors were noted during the four months of observations (Bergin, Ford, & Hess, 1993). Examples of peer cooperation included providing assistance

and instruction and managing turns. The most common type of teacher-child interaction was the teacher verbally instructing the student on new concepts related to the computer.

In a two-part study conducted by Muller and Perlmutter (1985), social interactions at the computer area and puzzle area were compared. Twenty-seven (27) 3-5-year-old children were observed during computer play, and subsequently during puzzle play. During computer time, 70% of the interactions children were observed “sharing” the computer (Muller & Perlmutter). The remaining 30% of the time was divided equally among doing, explaining, and showing activities.

The study found that children spent significantly less time engaging in peer interactions while at the puzzles than they did while at the computers (Muller & Perlmutter, 1985). Peer interaction was present during 63% of the computer play and only 7% of the puzzle play. In addition, 11% of the time was spent in solitary activity at the computer and 55% of the time was spent in solitary activity with the puzzle. There was no significant difference in amount of teacher interaction for the two learning areas.

### Classroom Interaction Patterns

Three studies observed changes in interaction patterns for the overall classroom. In a sample of 44 preschool children, preschool staff were interviewed regarding the children’s peer groupings in order to determine whether these already-established groupings changed with the introduction of the computer (Swigger & Swigger, 1984). Results indicated that introducing a computer to a classroom did not interrupt already-established social groups and that most children preferred to play at the computer with their close friends.

The introduction of the computer into this preschool classroom also served to reinforce the current leadership structure of the classroom (Swigger & Swigger, 1984). Those children that were previously identified as leaders in the classroom exerted their leadership in terms of the computer as well. One additional leader emerged in the classroom as a result of the introduction of the computer. This child had previous knowledge about the operation of a computer. This new leadership role can serve to greatly increase a child’s

confidence among his peers and promote initiation and helping behavior by a child that may not have previously demonstrated it.

Overall classroom interactions were observed on alternating computer-in and computer-out days in another study (Fein et al., 1987). Thirty children ages 3-5 participated in this study. Parallel play was the predominant mode of play regardless of whether or not the computer was present. Computer-in days did not change the frequency of onlooker or solitary play. Computer-in days did see more parallel play, less unoccupied play and less interactive play than computer-out days.

Similar results in overall classroom interactions were found in a study of 42 children in two classrooms (Anderson, 1998). The computer center was home to more parallel play than the other learning centers and less cooperative play. There was no difference in the frequency of solitary, onlooker, unoccupied, disruptive, teacher-initiating interaction, or child-initiating teacher attention.

Both of these studies indicated that parallel play is the most common form of play with these preschool children. Despite some critics' concerns, frequency of solitary play did not increase with the introduction of the computers. Also, despite some supporter's beliefs, frequency of interactive or cooperative play decreased when computers were present. Initial fears of social isolation were unfounded and overall, the social environment of the classroom did not appear to change substantially with the introduction of computers.

There are several limitations to the literature on the social impact of computer use. All of the studies presently available involve small sample sizes, usually of only one or two preschool classrooms. In addition, most of the studies were performed in university lab preschools with mostly middle class white children. Finally, most of the studies lacked comparable definitions of social interactions. For example, one study reported high rates (70%) of sharing behaviors (Muller & Perlmutter, 1985) and another study, reported cooperation levels decreased with the introduction of computers (Anderson, 1998). However, neither study provided clear definitions of these behaviors.

## IMPACT OF EARLY COMPUTER USE ON COGNITIVE DEVELOPMENT

One concern regarding the early introduction of computers is that computers are too difficult for young children to understand and use appropriately (Goodwin et al., 1986; Simon, 1985). In addition, many critics express concern that computers will cause a loss of creativity in young children (Cordes & Miller, 2000). Several studies will be presented here outlining the cognitive outcomes of early computer use. These studies will be discussed in the context of two notable theories of child development by Jean Piaget and Lev Vygotsky.

### Jean Piaget

Jean Piaget theorized that children are innately gifted, active learners, familiarizing themselves with the world long before we ever realized (Papert, 1980). He stated that children construct knowledge independently through their experiences with the world (Schetz & Stremmel, 1994). Given this framework, teaching methods with a Piagetian perspective has resulted in the belief that children need direct experiences and active involvement in their world through exploration and play (Schetz & Stremmel).

Piagetian perspective has extended to the use of computers with young children through one of Piaget's students, Seymour Papert. In his 1980 book, *Mindstorms*, Papert argued that computers are a good tool for promoting this kind of active discovery because computers allow children to be in control of their own learning. Despite not being able to physically manipulate a computer, computers do still provide direct, meaningful learning experiences that are consistent with Piagetian theory (Clements et al., 1993).

In one study, parents of 3-5-year-old children completed a questionnaire that assessed the child's at-home computer use (Li & Atkins, 2004). Each child's cognitive development and school readiness skills were assessed. After controlling for SES, children that had computer access scored significantly higher on both the cognitive and the school readiness assessments.

Another study examined 49 children in four preschool classrooms (Haugland, 1992). Treatment groups were divided along classrooms. One classroom contained computers with developmentally appropriate software

and supplemental activities. The supplemental activities were placed on a table next to the computers and were designed to incorporate concepts learned on the computer into hands-on classroom activities. The second classroom contained developmentally appropriate software with no supplemental activities. The third treatment group had nondevelopmentally appropriate software. A control group with no computer access was also included. Children were assessed pre- and posttest for intelligence, creativity, and self-esteem.

Significant differences on measures of intelligence were observed for children in the developmentally appropriate software with supplemental activities group and the developmentally appropriate software group (Haugland, 1992). Children in the developmentally appropriate with supplemental activities group scored significantly higher posttest on six out of eight of the cognitive subtests. Children exposed to developmentally appropriate software without supplemental activities gained in cognitive skills on four out of eight of the cognitive subtests. Nondevelopmentally appropriate software was related to a gain only in the subtest of attention enhanced. Children in the control group exhibited no significant gains in cognitive development from the pre- to posttest period.

These findings provide support for Papert's argument that computers provide children with opportunities for active learning. In Haugland's (1992) study, children who were exposed to the nondevelopmental software (a drill-and-practice program) were mesmerized by the computer screen and therefore were not able to actively participate and react to their environment. These children exhibited no significant gains in intelligence. The developmental software allowed children to become actively engaged in the experience and allowed children to have a degree of control over their environment. These children exhibited gains in many areas of cognitive development, which supports Piagetian theory that children learn best when actively engaged in their environment.

Some authors argue that while Piaget provides a good framework for children's learning through computers, it is an individualist view that may not apply to an educational setting like preschool, where peers and teachers have such an active influence (Schetz & Stremmel, 1994). They assert that a Vygotskian perspective of socially mediated cognitive development can more appropriately be applied to technology in the preschool.

## Lev Vygotsky

According to Vygotsky, children do not learn through independent exploration, instead, they learn through the structuring of a task by a more experienced partner (Vygotsky, 1978). The partner's role is to recognize the child's abilities, and stretch those abilities by working within that child's zone of proximal development. The zone of proximal development is the difference between what a child can learn by himself and what he can learn with a skilled partner. The more skilled partner uses scaffolding to break the task into manageable pieces that the child can handle, gradually increasing the complexity of the task for the child. Scaffolding strategies include such actions as pointing to the task, reminding, suggesting, and questioning (Schetz & Stremmel, 1994).

Many authors have discussed the usefulness of Vygotskian theory to describe the benefits of early computer use (Downes, Arthur, & Beecher, 2001; Robinson, n.d.; Samaras, 1996; Schetz & Stremmel, 1994). The role of the teacher is to be aware of the child's computer skill level and to provide an appropriate amount of assistance (Samaras). Teachers should engage in collaborative problem solving with the child and provide verbal and nonverbal feedback and instructions (Samaras; Schetz, 1994).

Vygotsky (1978) also asserted that peers play a vital role in young children's learning. Computers provide a unique learning environment for peer scaffolding. Children find it irresistible to work together at the computer and are able to create a "shared problem space" in which they complete tasks and solve problems together (Freeman & Somerindyke, 2001).

***Adult-provided scaffolding.*** One study involved a sample of 150 5-6-year-olds. After extensive teacher training, teachers and the children in their classroom were placed in one of three groups: mediation, accompaniment, and no assistance/control group (Nir-Gal & Klein, 2004). In the mediation group, teachers helped the children focus on the task, they expanded and encouraged children's thinking, and regulated children's behavior. Teachers in the accompaniment group were instructed to only respond to children's questions. Teachers in the third group, no assistance/control provided only minimal technical assistance. Children were assessed in the beginning and the end of the school year on abstract reasoning, vocabulary, visuo-motor coordination, and planning behavior. Results showed that children in the mediation group scored significantly higher than both groups on all measures (Nir-Gal & Klein). Furthermore, there were no significant differences

between the accompaniment and the no assistance groups on any of the measures.

Another study of 212 preschool children found similar results (Primavera, Wiederlight, & DiGiacomo, 2001). Eighty-nine children were assigned by classroom to a traditional access group, in which computers were placed in the classroom and used in the traditional way that teachers implement computers. The remaining 123 children were assigned to a mentor mediated group, in which the children participated in 15-30 minute weekly training sessions with a research assistant for the entire year. The content of the training included the names and functions of the computer components and how to navigate the software.

School readiness was measured through a computer program designed to assess the child's skill level based on their performance, and adjust the difficulty level of the software accordingly (Primavera et al., 2001). The two groups were not significantly different in their performance on the program at pretest. Posttest results indicated that 30% of the mentor mediated students performed at the mastery level, compared to only 1% of the traditional access group.

***Peer-provided scaffolding.*** One experimental study addressed the significance of peer interaction on cognitive performance with preschool children (Perlmutter, Behrend, Kuo, & Muller, 1989). Two to three days after a 20-minute training sessions, 20 children were randomly assigned to work on the computer alone and 40 children were assigned to work in pairs on the computer. Groups were matched on age, sex, and intellectual ability. The experimenter was always present and remained as unobtrusive as possible. Children were also given a memory test two weeks later.

The results showed that children, particularly older preschoolers (ages 5-5½), who worked in pairs scored higher on both free recall and cued recall memory than those who worked alone (Perlmutter et al., 1989). For younger children (ages 3-4), however, fewer correct responses were produced in the paired condition. Because this study occurred over only a very short time period and did not occur in a naturalistic setting, these findings are limited in their generalizability.

***Software-provided scaffolding.*** One study examined computer software that provided scaffolding based on the child's performance (Shute & Miksad,

1997). Children were randomly assigned to one of three groups: (a) substantial computer scaffolding, (b) minimal computer scaffolding, and (c) a control group that had no computer access. The students in the control group did, however, participate in hands-on activities that were parallel to the activities of the computer. For example, if a computer task required children to count balloons, the related task would have children count real balloons. Students in the control group were also provided with minimal teacher scaffolding.

Children in the substantially scaffolded group scored significantly higher on measures of cognitive development than both other groups. The authors concluded that controlling for scaffolding level, computers produce similar results as traditional teaching methods (Shute & Miksad, 1997). The finding that substantial computer scaffolding does increase cognitive abilities is important. Although we don't know whether substantial teacher scaffolding on noncomputer activities would produce similar results, the likelihood that early childhood teachers can provide such substantial scaffolding for individual children on a daily basis is slim, given limited time and resources. In a discussion of this study, Robinson (n.d.) highlighted the potential benefits of having software that substantially scaffolds children's learning experiences. Not only does this scaffolding lead to cognitive gains but also increases children's independence in learning and, as stated earlier, required less interference of busy teachers.

There are several limitations to be noted in the research on the impact of the computer on cognitive development. First, only three studies were found that compared computer use with no computer use. While these preliminary results indicate that computers have a beneficial effect on cognitive skills, this area of research is not fully developed. The need exists for true experimental research that clearly compares computer use with no computer use. Second, only one study examined the impact of peer scaffolding on cognitive development (Perlmutter et al., 1989), and this study suffered some methodological weaknesses. Finally, while adult scaffolding appears to mediate the impact of computers on cognitive development, more studies are needed in this area as well.

## IMPACT OF EARLY COMPUTER USE ON LANGUAGE DEVELOPMENT

One concern in the literature is that computer use will inhibit language development among young children. One study examined language use among 25 children in the computer, housekeeping, library, blocks, and art areas of a preschool classroom (Kelly & Schorger, 2001). Twenty-one (21) children exhibited no significant difference in amount of language used at the computer learning center compared to the traditional learning centers. Of the three children that did exhibit a difference in language depending on location, one child used significantly more language at the computer center and the other two children used significantly less language at the computer center. The authors concluded that the use of computers in a preschool classroom does not significantly inhibit or encourage language use. Therefore, computers provide equally language-enriching environments for young children.

A second study examined the type of language used by young children at the computer (Bhargava & Escobedo, 1997). Four preschool children were observed while playing on the computer in pairs. Researchers found that language almost always was related to the use of computers, and was not considered off-task. Language use became more common and more complex as time went on. For example, self-talk was the primary form of language in the beginning, as children were becoming comfortable with the new experience and acted as a bridge between internal thought and verbal speech. Later, children used language to solve problems and to anticipate cause and effect. Authors concluded that when computers are appropriately placed, they can foster the use of language and social interactions among children.

Ninety-three Head Start children were assigned by classroom to one of three treatment conditions in another study (Schetz, 1994). In the first condition, children participated in a language-enhanced computer activity with the assistance and scaffolding of a trained instructor. The purpose of this instructor was to assist the child on the computer, to encourage language use, and to ask the child questions during the session. The second treatment provided children with the same computer software and a passive instructor, whose purpose was to encourage children to answer questions asked by the computer and encourage on-task behavior. The third group was a control group in which children did not have computer access and only participated in the regular language-enrichment activities familiar in all Head Start classrooms.

Although children in the computer-assisted environments did have gains in language development over time, these gains were not significantly greater than the gains experienced by children in the traditional language-enriched setting (Schetz, 1994). Authors concluded that had they had a larger sample size or if their classrooms had not experienced multiple difficulties (high teacher turnover, technical difficulties), the results may have reached statistical significance. However, given the present results, it could not be concluded that computer-assisted language instruction is more beneficial than the traditional language-enhanced classroom.

The studies presented here indicate that while computers may not enhance gains in language development, computers do provide an environment in which children use a large amount of language, similar to other learning areas of the classroom. These results should be interpreted with caution, however. The sample sizes were quite small in each group and a control group was used in only one of the studies.

### IMPACT OF EARLY COMPUTER USE ON MOTIVATION

Supporters of early computer use contend that children have a strong motivation for learning when using computers. Children find computers to be entertaining and enjoy using them, all while they are learning. Educators find it hard to dismiss this notion given that some other teaching methods are met with resistance from children. The present section will examine the research that examines the motivation of young children to use computers.

In one study, researchers recorded the behavior of 95 kindergarten children while on the computer (Bergin et al., 1993). Teachers agreed to have children work in pairs at the computer and that each child would receive at least one hour at the computer per week. Researchers used four categories to code computer behavior: (a) on task, (b) off task, (c) ordinary interest (face was neutral, but obviously on task or interested), and (d) strong positive affect (excited behavior, singing, pointing to screen, high amplitude smile or laugh).

The study found that children were on-task 90% of the time while on the computer (Bergin et al., 1993). This indicates that computers provide a highly motivating opportunity to learn for young children. Novelty effects

were evident because at first children would become highly excited and emotional while on the computer, but in later observations children were not as emotional, although still highly engaged and exhibited high amounts of attention to the computer. The highest levels of excitement were exhibited when children were working in pairs toward a goal on the computer. This situation appeared to be the most highly motivating environment, which is consistent with previous research (Bergin et al.).

Twelve preschool children in another study used computer software designed to help them learn spatial relationships (Liu, 1996). The children's facial and verbal expressions were observed to determine the child's motivation to use the computer program. Eighty-three percent (83%) of the children immediately recognized the program (a Jungle Book learning program) and were excited to see it. Many children (75%) laughed and smiled during the program. When the children were asked about their experience on the computer, many asked when they could play it again and they all said they enjoyed playing.

In another study, the facial expressions of 16 preschool children were videotaped while the children used three pieces of computer software: a counting program, a face construction program, and a drawing program (Hyson, 1985). There were no instances of negative facial expressions with any of the programs, and all three software programs elicited positive emotions from all children. These results were compared with a three-minute segment of the same children watching a *Sesame Street* episode on television.

While using the computer, children were more likely to talk to or look at the experimenter than children watching TV (Hyson, 1985). Children demonstrated more active interest and joy when using the computer programs. They also showed more concentration using the computer than watching TV. As evidenced by their greater use of facial blends and changes in expression, children using the computer seemed to be engaged in a more cognitively complex activity. It was concluded that the children had more motivation for using the computer, were more happy using the computer, and appeared to "get more out" of that experience. The author stated that this may be because children were in control of their activity while using the computer. When the children watched TV, they were merely passive observers.

While the samples in most of these studies are small, some general findings emerged from these studies. Computers are highly motivating for young children to use. Young children exhibit mostly positive emotions while on the computer and remain on-task for a significant majority of the time while on the computer. Using a computer also appears to be more cognitively complex than watching educational TV programming. Knowing that children are highly motivated to use computers and that computers provide potential benefits to children's cognitive skills, computers can be viewed as another useful method for teaching young children.

## DISCUSSION

Young children are increasingly being exposed to computers in the home and at preschool. There is sharp disagreement, however, about whether computer use is harmful or beneficial to young children's development. This literature review explored research regarding the impact of computer use on young children's social, cognitive, language development, and motivation.

Despite early concerns that computers would cause children to become socially isolated from peers and teachers, all studies have found this to not be the case. In fact, children rarely played on the computer by themselves and even in one study where teachers tried to have children to play alone on the computer, children continued interacting with peers (Freeman & Somerindyke, 2001). There were also more peer interactions observed than teacher interactions. Very few conflicts were reported and usually consisted of arguments over turn-taking and sharing of the computer.

The impact of technology on the overall interaction patterns in the classroom was also explored. These results indicated that parallel play was still the most common form of interaction in preschool classrooms. Solitary play did not increase in the classrooms and cooperative/interactive play decreased slightly.

Although the studies on early computer use and cognitive development generally have small sample sizes, the research does still suggest a trend toward a cognitive benefit of computer use. Young children that use computers do show more gains in cognitive skills compared with children that do not have computer access. Computer play is consistent with both Piagetian theory and Vygotskian theory. Children are actively engaged while

on the computer and have control over their play. The assistance of teachers and more experienced peers also appears to aid in the cognitive benefits of computers.

Although computers do not appear to enhance language development any more than traditional teaching methods, computers do provide an environment in which children use a large amount of language with both peers and teachers. Computers also appear to be highly motivating for young children. They generally have very positive experiences on the computer and tend to stay on task for a long period of time.

Given numerous potential confounding factors and the wide developmental stages of children being affected, it is almost impossible to make a broad-based general argument for or against computer use at school and home. Instead, we need studies with vigorous research methodology in well-defined learning environments to examine the gains/losses across multiple developmental domains that might provide informative data for parents, teachers, and policy-makers.

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## Note

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