**Technology Access for Low-Income Preschoolers:
Bridging the Digital Divide [1]**

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Abstract

The proliferation of technology has dramatically altered many facets of American society, especially education and the workplace. However, a "digital divide" cuts across socioeconomic lines separating higher income families with technology access from lower income families without. This technology training project provided computer access and training to low-income preschool-age children in an urban Head Start program. Traditional Access and Mentor Mediated Instruction conditions were studied. Children in both conditions received daily access to computers and supervision from classroom teachers. In addition, the Mentor Mediated Instruction group also received weekly computer training from an undergraduate technology trainer. Results indicate that all children displayed larger working technology vocabulary, a greater understanding of how a computer operates, increased computer skills, an increase in kindergarten readiness skills, more favorable attitudes towards learning, increased self-esteem and self-confidence, and improved social interactions with peers and adults. These positive effects were significantly greater for children in the Mentor Mediated Instruction group.

Technology Access for Low-Income Preschoolers:
Bridging the Digital Divide

Within the past two decades, the proliferation of technology has changed the face of American education and the American workplace. Indeed, the ability to effectively use a computer has become as fundamental to a person's academic and occupational success as reading, writing and arithmetic (U.S. Department of Education, 1996). National surveys suggest significant support for providing children with access to computers to enable them to learn adequate computer skills and to enhance their educational experience (Trotter, 1998). Computers have become a staple in the homes of families with children. For children between the ages of 2-17 the number of homes with computers has increased from 48% in 1996 to 70% in 2000 with Internet connection rising from 15% to 58% in the same five year period (Woodward & Gridina, 2000). Indeed, there is a "digital divide" in this country which further separates the "haves" from the "have nots" of American society (U.S. Department of Commerce, 1995; 1997; 1999). Children "at risk" for "technological failure" come from the same disenfranchised groups that are disproportionately represented among students exhibiting underachievement and school failure - children of color living in poor urban and rural neighborhoods.

The "digital divide" falls along traditional socioeconomic, racial, geographic, and educational lines. The most obvious divide is family income. For example, only 12.9% of families earning less than $15,000 per year own a home computer. For families earning between $15,000 and $30,000 per year computer ownership increases to a mere 24%. However, when family income exceeds $75,000 per year, computer

ownership jumps to 80%.   At all income levels, White families are more likely to own a

computer than Black and Hispanic families.   Dual parent homes are twice as likely to

have a computer than single-parent families (62% vs. 32%). Computer ownership is

lowest in households in the central city and rural areas. Also, computer ownership

follows educational attainment in that 63% of those with a Bachelor's Degree own a

computer, 27% of those who have attained a high school diploma or GED, and only 9%

of those people who did not graduate from high school own computers (U.S.

Department of Commerce, 1997).

The breadth of this technological inequality has led some to look to the schools to

provide less-advantaged children with some semblance of equal opportunity for both

computer access and computer skill development (Becker, 2000). Recent surveys

suggest that in terms of access, the divide has narrowed considerably. Schools in high-

poverty communities have one computer for every 5.3 students which is comparable to

the national average of 4.9 students per computer (Bushweller & Fatemi, 2001).

However, there is a new divide, a new inequality that exists in terms of how computers

are used and the skills that the children are being encouraged to develop. That is,

computer use in low-income schools more often than not adheres to more traditional

practices and beliefs about student learning, whereas computer use in high-SES

schools often reflects more constructivist and innovative teaching strategies. In low-

SES schools computers are most frequently used for remediation of a skill, practice of a

skill recently taught, and to help students work independently. In high-SES schools,

students are more likely to use computers to enhance their writing skills, to make

presentations to an audience, and to analyze information (Becker).   How this trend

translates down to the preschool and early childhood level is unclear; however, with only 38% of children age 3-5 years using computers at home or at school (Kominski & Newberger, 1999), it is likely that the inequalities of the "digital divide" are present for our nation's youngest students as well.

While the appropriateness of computer use by young children has been debated for nearly twenty years (e.g., Shade & Watson, 1990; Subrahmanyam, K., Kraut, R.E., Greenfield, P.A., & Gross, E.F., 2000), a recent report by the Alliance for Children (Cordes & Miller, 2000) has fueled the controversy. The report warns that, in spite of the promises for a brighter future made by computer advocates, the risks to children far outnumber the benefits.   Some experts contend that computers are not appropriate for young children and serve only to contribute to their "miseducation" (Elkind, 1987; Healy, 1998). Critics of early childhood technology contend that computer use by young children has deleterious effects on their physical, cognitive, social-emotional, and psychological development.   More specifically, risks to physical development include repetitive stress injuries, vision problems, seizures, lack of exercise and obesity, and potentially harmful exposure to toxic emissions and electromagnetic radiation. Cognitive development is affected by decreased creativity and stunted imagination, loss of wonder, impaired language and literacy skills, poor concentration, and little patience for hard work. Risks to emotional and social development include social isolation from peers and adults, decreased motivation, loneliness, depression, as well as potential exposure to pornography, violence, drugs, and race hatred via Internet access (Cordes & Miller, 2000).

Still, a wealth of literature exists which contradicts this negative view of children as computer users. Research suggests that technology, when used correctly, can enhance how a child learns by offering the child opportunities for: active engagement in the learning process, cooperative learning, frequent interaction and feedback, and a sense of connection to real-world contexts and applications (Roschelle, Pea, Hoadley, Gordin & Means, 2000).   Advantages in the areas of fine motor skills, language and communication, reading readiness skills, mathematical thinking, academic achievement, creativity, critical thinking, problem solving, self-concept, self-confidence, cooperation, motivation, and positive attitudes towards learning have been found (Clements, 1987; 1998; Haugland & Wright, 1997).

The present work summarizes the findings from a technology access and training program for low-income children enrolled in an urban Head Start program. The study explored the effects of early technology use on the children's academic and social-emotional development using two different implementation strategies.

Method

Technology Training Program Overview

The child technology training program is a component of the Fairfield University – ABCD Literacy Technology Training Center. The Technology Training Center takes place within the larger context of The Adrienne Kirby Family Literacy Project; a competency-enhancing program focused on the development of literacy and school readiness skills (Primavera, 1999; 2000: Primavera & Cook, 1996). The Project involves a collaborative partnership between Fairfield University and Action for

Bridgeport Community Development (ABCD), the oldest community service agency and

largest childcare provider for Bridgeport, CT. All of the children participating in the

technology training project were enrolled in ABCD's Head Start/Childcare program.

Thus, computer access and technology training were linked to the larger Kirby Project

goal of literacy enrichment.

Each Project preschool classroom was equipped with a computer learning station

from the Hatch Corporation (Winston-Salem, NC). These computers provide mouse,

keyboard, and touch screen access capabilities to accommodate the children's varying

fine motor skills and to allow for cooperative computer use. The computers were loaded

with fourteen different children's educational software packages as well as Windows

98/Microsoft Office and Internet capabilities.

Participants

Participants were 295 children enrolled in an urban Head Start/Childcare

program during the 2000-2001 academic year.   Their ages ranged from 2 years, 10

months to 4 years, 9 months; 51% were male and 49% female; 56% were Black, 37%

Hispanic; 5% White, and 2% "other"; 26% came from homes with annual incomes of

less than $9,000, 35% with incomes between $9,000 and $14,999, 35% between

$15,000 and $29,999, and 4% with incomes over $30,000; 68% were from single-parent

families. Thirty-three percent of the families owned a home computer.

Procedure

Classrooms were randomly assigned to two training conditions, "Traditional

Access" and "Mentor Mediated Instruction".   There were 10 Mentor Mediated

classrooms (N = 169 children) and 7 Traditional classrooms (N = 126 children).   Ninety-

four children were dropped from the sample because they left the Head Start/Childcare program, transferred out of the classroom, or had excessive absences leaving a total of 123 children in the Mentor Mediated Instruction group and 89 in the Traditional Access group.

In both the Traditional Access and the Mentor Mediated Instruction conditions, classrooms were provided with a computer workstation, educational software, classroom teacher training, and ongoing technical assistance from university Project staff. Also in both conditions, the computer was utilized as one of several "learning stations" available in the classroom. Children had daily access to the computer and classroom teachers monitored the children's computer use and provided instruction depending on the teacher's interest and/or skill. Classrooms receiving this basic access and training were designated "Traditional Access" classrooms. That is, this condition mimicked the typical way computers are utilized in educational settings where the computers are used as one of many learning resources in the classroom and the teacher oversees student access.   The "Mentor Mediated Instruction" condition differed from the Traditional Access group in one respect - the children received weekly computer training from an undergraduate technology trainer. Children in the Mentor Mediated Instruction group experienced an average of 16 training sessions (range = 10 - 31 sessions).   The training sessions were typically 15 –30 minutes in length.

The training protocol focused on teaching the children a set of basic computer skills while using educational software. Within the context of "playing" with educational software, the children were instructed as to the proper names and functions of the parts of the computer workstation and shown how to properly operate the computer and

navigate through software programs. Choice of the software program utilized during a session varied according to the child's interests, needs, and skill level. At all times, the technology trainers encouraged the use of proper computer vocabulary (e.g., "monitor" not "TV"). Likewise, trainers utilized naturally occurring opportunities to encourage a basic understanding of how a computer operates (e.g., "The CPU does all the thinking and makes everything else work." … "The monitor shows you what the computer is thinking. It lets you see the games or pictures the CPU is thinking about." … "The CD-ROM has games and stories on it. The computer needs the CD-ROM to remember the game or story") and how to correctly execute procedures needed to load, select, run, print, and exit a software program. The undergraduate technology trainers worked with children individually or in small groups depending on the children's needs, temperament, and abilities.

There were 24 undergraduate technology trainers. The Project Director and three graduate student assistants provided training and supervision.

Instruments

School Readiness Skills. The Jumpstart Pre-K software program (Knowledge Adventure) measures a variety of kindergarten readiness skills. More specifically, the Jumpstart Pre-K program assesses: language arts (letter recognition, letter sequences, letter sounds, listening and comprehension), mathematics (number recognition, counting, shape recognition and sorting by attribute), and fine arts (colors, patterns, music, and visual memory). The Pre-K Jumpstart program consists of nine different "games" which reflect each of the aforementioned school readiness skills. Each "game" has three levels of difficulty. Mastery of level 3 indicates a readiness to advance to

kindergarten-level tasks and skills. Thus, for the purposes of this study, kindergarten

readiness was assessed via a Difficulty Level Score (i.e., the overall level of skill

difficulty the child was working at: beginner, intermediate, or mastery level) and a Total

Score indicating the percentage of correct responses during the pre- and post-test

protocol.

Computer Knowledge Scale (CKS). The Computer Knowledge Scale

(Primavera, DiGiacomo & Wiederlight, 2001) measures an individual's knowledge of (1)

the correct name for the eleven different components of the computer station, i.e.,

"computer vocabulary" (e.g., CPU, monitor, mouse, cursor, keyboard, CD-ROM drive,

CD-ROM, floppy disk drive, floppy disk, speakers, printer) and (2) what that computer

part "does", i.e., its function. The participant is seated at a computer station and the

trainer points to a component and asks the participant to identify its name and function.

The section of the CKS dealing with computer vocabulary is administered both

expressively (i.e., "tell me the name of this computer part") and receptively (i.e., "Point

to the CPU, monitor, etc"). The CKS yields a Computer Vocabulary Score and a

Computer Function Score. Higher scores indicate greater knowledge (range = 0 – 11).

Inter-rater reliability was .98.

The Children's Computer User Assessment Scale (CCUAS).   Undergraduate

technology trainers evaluated the children's technology skills and attitudes using the

CCUAS. The CCUAS was developed for this Project and utilizes 5-point Likert scales

to assess the child's: confidence as a computer user (1 = not confident, 5 =

exceptionally confident), level of anxiety (1 = not anxious, 5 = exceptionally anxious),

understanding of how the computer works (1 = no understanding, 5 = exceptional

understanding), ability as a computer user (1 = no ability, 5 = exceptional ability), and overall improvement (1 = no improvement; 5 = superior improvement). The CCUAS was used only for children in the Mentor Mediated Instruction group. However, to compare the children's progress in the Traditional Access versus the Mentor Mediated Instruction groups, classroom teachers rated the children's ability as a computer user using the aforementioned 5-point Likert scale (1 = no ability, 5 = exceptional ability). The CCUAS also includes a "Computer Skill Checklist" which assesses whether or not a child has mastered each of ten basic skills (e.g., "able to properly turn the CPU on and off").

Focus Groups. Two focus groups involving the 13 teachers from the Mentor Mediated Instruction classrooms and three focus groups involving the 24 undergraduate technology trainers were held in May 2001. The topics discussed included an evaluation of the Project's impact on the children's academic and social-emotional development as well as questions related to the structure of the technology Project, the impact of the Project on teachers and undergraduate trainers, and the larger social issue of the "digital divide".

Results

Both quantitative and qualitative data analyses techniques were utilized to assess the impact of computer technology access and training on low-income preschooler's academic and social development. First, a series of analyses compared the kindergarten readiness skills and computer knowledge and ability of the children whose exposure to computers followed the more traditional format of receiving

supervision from classroom teachers (Traditional Access group) to children who received additional weekly technology instruction from undergraduate technology trainers (Mentor Mediated Instruction group). A second series of analyses considered the changes in attitudes and behaviors of the children in the Mentor Mediated Instruction classrooms only. Finally, common themes emerging from the teachers' and technology trainers' focus groups with both the classroom teachers and the undergraduate technology trainers are presented.

Kindergarten Readiness Skills and Computer Skills: Traditional Access versus Mentor Mediated Instruction

In this series of analyses, the performance of children in the Mentor Mediated Instruction group was compared to the Traditional Access group. Chi square analyses were used to assess differences in the Jumpstart Pre-K kindergarten readiness Difficulty Level Score. Changes in performance on the Jumpstart Pre-K Total Score, the Computer Knowledge Scale, and classroom teachers' ratings of computer ability were compared using repeated-measures ANOVAS. Subsequent individual t-tests were performed using Bonferonni method of multiple comparisons at the .01 level.

Kindergarten Readiness. The Chi square analyses revealed that children in the Mentor Mediated Instruction group displayed significantly more progress in their kindergarten readiness skills than children in the Traditional Access group. The 2 x 3 (Group x Level) Chi square analysis at pre-test was not significant. Chi square analysis at post-test revealed greater school readiness skills in the Mentor Mediated Instruction group, $X^2 = 27.42$, df = 2, $p < .001$. That is, significantly more children in the Mentor Mediated Instruction group had progressed to the intermediate or mastery levels of

kindergarten readiness skills than the children in the Traditional Access group. The

percentage of children performing at each level is shown in Table 1.

Table 1
School Readiness Performance Levels

PERFORMANCE LEVEL	Beginner	Intermediate	Mastery
Pre-test			
Mentor Mediated Instruction	89%	10%	1%
Traditional Access	93%	6%	1%
Post-test			
Mentor Mediated Instruction	26%	43%	31%
Traditional Access	55%	41%	1%

Group differences in overall kindergarten readiness as measured by the Jumpstart

Pre-K Total Score was assessed via a repeated-measure ANOVA. The

analysis showed superior kindergarten readiness skills in the Mentor Mediated

Instruction group, $\underline{F}$(1, 193) = 15.70, $\underline{p}$ < .001.   The analysis also revealed an overall

increase in skills over time for all children, $\underline{F}$(1,193) = 158.20, $\underline{p}$ < .001, but that increase

in readiness skills was greater for the Mentor Mediated Instruction group, $\underline{F}$(1, 193) =

7.13, $\underline{p}$ < .01. Subsequent t-tests with Bonferonni adjustments for multiple comparisons

($\underline{p}$ < .01) showed that, at pre-test, the performance of children in both groups did not

differ significantly (Mentor Mediated Instruction mean = 34%; Traditional Access mean =

31%). At post-test, the kindergarten readiness skills of children in the Mentor Mediated

Instruction group's were significantly greater then children experiencing Traditional

Access, $t(193) = 5.09$ (Mentor Mediated Instruction mean = 49%; Traditional Access mean = 40%).

Computer Knowledge and Skill. The repeated-measures ANOVAs assessing the children's technology knowledge as measured by the Computer Knowledge Scale revealed that the Mentor Mediated Instruction group had a larger working technology vocabulary, $F(1, 200) = 65.24$, $p < .001$, and a greater understanding of how a computer operates, $F(1, 200) = 21.79$, $p < .001$. The analyses also showed that the children's computer vocabulary, $F(1, 200) = 323.32$, $p < .001$, and knowledge of computer workstation functions $F(1, 200) = 108.79$, $p < .001$, increased significantly over the course of the school year. However, for children in the Mentor Mediated Instruction group this increase in computer literacy was more pronounced than for children in the Traditional Access group. That is, the children who experienced weekly technology mentoring sessions with the undergraduate technology trainers learned to correctly identify more of the components of the computer workstation, $F(1, 200) = 65.24$, $p < .001$, and demonstrated a greater understanding of the function of the workstation components, $F(1, 200) = 21.79$, $p < .001$, than the children in the Traditional Access group. Subsequent t-tests with Bonferonni adjustments for multiple comparisons ($p < .01$) showed that, at pre-test, the children in both groups had equivalent computer vocabularies (Mentor Mediated Instruction mean = 2.1; Traditional Access mean = 2.3) but by post-test children in the Mentor Mediated Instruction group could correctly identify significantly more computer workstation components, $t(200) = 12.44$ (Mentor Mediated Instruction mean = 7.5; Traditional Access mean = 3.3). Similarly, at pre-test, there was no significant difference in the children's understanding of how the computer

workstation functions (Mentor Mediated Instruction mean = 0.66; Traditional Access mean = 0.61) and at post-test children in the Mentor Mediated Instruction group demonstrated significantly superior knowledge of how the computer functions, $\underline{t}$(200) = 4.68 (Mentor Mediated Instruction mean = 2.0; Traditional Access mean = 1.12).

The repeated-measures ANOVA assessing teacher evaluations of the children's overall ability as a computer user (defined as the ability to get the computer to do what you want it to do) revealed that teachers perceived children in the Mentor Mediated Instruction group to be more competent computer users, $\underline{F}$(1, 196) = 10.15, $\underline{p}$ < .01; that the children's ability as computer users improved over the course of the school year, $\underline{F}$(1, 196) = 85.15, $\underline{p}$ < .001; and that the improvement in computer skills was greater for children in the Mentor Mediated Instruction group than for children in the Traditional Access group, $\underline{F}$(1, 196) = 3.45, $\underline{p}$ = .05. Subsequent t-tests with Bonferonni adjustments for multiple comparisons ($\underline{p}$ < .01) showed that, at pre-test, the children in both groups were perceived by teachers to have equivalent computer abilities (Mentor Mediated Instruction mean = 1.9; Traditional Access mean = 1.7). However, at post-test, children in the Mentor Mediated Instruction group were perceived as being more skilled computer users, $\underline{t}$(196) = 4.15 (Mentor Mediated Instruction mean = 2.8; Traditional Access mean = 2.2).

Changes in Behavior and Attitudes with Technology Training

In this series of analyses, changes in behavior and attitudes over the course of the school year (September 2000 to May 2001) were explored for the children receiving weekly computer instruction from undergraduate technology trainers (i.e., the Mentor Mediated Instruction group). Ratings by the undergraduate technology trainers on the

Children's Computer User Assessment Scale were used to assess the children's level of anxiety when using the computer, their confidence as a computer user, their understanding of how a computer works, and the overall improvement in their computer skills.

Anxiety Level. A paired sample t-test found no significant change in the children's level of anxiety when using the computer. However, overall, the children exhibited very little anxiety to begin with. That is, at pre-test and at post-test, only 2% of the children were rated as displaying significant anxiety when using the computer.

Confidence as a Computer User. A paired sample t-test revealed a significant increase in the children's confidence as a computer user, $\underline{t}(117) = 6.42$, $\underline{p} < .001$, over the course of the school year.

Understanding of how the computer works. A paired sample t-test showed that children's understanding of how the computer works increased significantly over the course of the training program, $\underline{t}(117) = 10.88$, $\underline{p} < .001$. In fact, by the end of the school year:

    90% of these preschoolers were able to properly turn the CPU on and off
    95% knew how to properly turn on and off monitor, speakers, and printer
    100% were able to use the mouse
    89% knew how to properly insert a CD-ROM into the CD-ROM drive
    49% knew how to use the printer
    86% were able to find, open, and change a software program
    80% were able to navigate through a software program with little assistance
    76% understood the consequences related to an action when interacting
        with a program
    84% used the computer cooperatively with another child
    87% were able to follow the instructions of the technology trainer

Overall Improvement in Computer Skills. Children were rated as showing

considerable improvement in their computer skills from the beginning of training to the

end of the school year. Ratings by undergraduate technology trainers were as follows:

39%	showed exceptional improvement
39%	showed a great deal (above average) improvement
16%	showed moderate (average) improvement
6%	showed slight improvement
0%	were rated as showing no improvement

Teacher and Trainer Focus Group Themes

Analysis of the two focus groups attended by teachers in the Mentor Mediated
Instruction group and the three focus groups attended by the undergraduate technology
trainers revealed significant gains for the children in the following areas:

- basic academic skills (basic preschool concepts)
- literacy skills and language development especially for non-English speaking children
- creativity
- interest in learning
- attention span and concentration
- memory skills
- ability to follow directions
- fine motor skills
- hand-eye coordination
- self-esteem
- self-confidence
- creative risk taking; more willing to try new things
- independence
- positive peer relationships
- cooperation and sharing
- impulse control

It is important to note that while all children were seen as benefiting cognitively

and emotionally from the technology training program in their classroom, both

classroom teachers and university technology trainers identified a group of "special"

children as reaping particularly important positive effects from their exposure to the

training program. They identified the developmentally delayed child, the child with

speech and language delays, the shy child, the child with limited English proficiency, and the child with behavioral problems as being particularly likely to benefit from the process of learning how to use the computer. In the words of one teacher,

"The computer makes things equal. It really helps those children who usually don't do too well, you know, who aren't as fast as other students or who are shy or who don't speak English fluently. The computer gives them a chance to be good at something. And so, it helps them in other things. It gives them confidence when they get on the computer, you know, confidence they didn't have for anything else. Now they'll go and try other things. They talk about things they never talked about before. The computer gives them something to be good at, something they can talk about and feel good about. They'll say, 'We saw that on the computer' or 'We did that on the computer'. They can be the 'helper' to other students instead of always being the one who needs help. They have something to be proud of. The computer is helping them so much."

In a similar vein, an undergraduate trainer provided the following anecdote:

"The children who don't speak English can be successful in communicating with the English-speaking kids on the computer. They have trouble in the rest of the classroom, you know, where they need hundreds and thousands of words to be successful. But that's not true in the computer area. One of the kids in my classroom knew no English at the beginning of the year. At first like 90% of her English words were about the computer or were something she learned from the computer. So by working on the computer they get the confidence to communicate. They are able to build friendships that they wouldn't be able to otherwise."

The focus group data also suggested that the benefits of the technology training program were not limited to the children ... there were noticeable positive repercussions for their parents and their teachers.   Parents and teachers were surprised at how much and how quickly the children could and did learn. They were impressed with the children's obvious enjoyment of the computer. They experienced a sense of pride in the children's accomplishments. They came to view technology as something that was

important to future success and something that they need not be afraid of. Parents and

teachers became interested in owning and learning how to use computers themselves.

According to one teacher,

> "So many of our children don't have computers at home. By having it in
> the classroom, the children who don't have one know what a computer is
> and how to use it...The parents get very proud when they come and see
> what their children can do with the computer...I know lots of parents who
> have actually invested in a computer...lots of them can't afford to buy one
> so they are going out and renting them, paying for them 'on
> time'...because they saw how well their children were doing on the
> computer and it really made them happy. Because they want their child
> to, you know, do as well and keep up with the other students...The parents
> are really interested in learning too and working with their children."

Another teacher describes the impact the training project had on her,

> "I used to be totally computer illiterate. I was afraid of the computer, afraid
> I'd break it or something...I took a computer class too and I didn't learn a
> thing. By having the computer in the classroom, that's the way I learned.
> From hands on in the classroom, just like the children and right along with
> the children...They learned faster then I did. If I didn't remember how to
> do something, they'd remember. The children taught me a lot...I saved up
> and now I have a computer at home too".

Discussion

The preschoolers who participated in the technology training project clearly

became quite skilled as computer users. Over 85% of the three and four years olds

receiving weekly training ended the school year able to properly start up and shut down

the computer, insert a CD-ROM, and use the mouse to open and navigate through a

software program. In contrast to most adults tackling computers for the first time, these

young learners embraced technology without fear or anxiety. It was, indeed, just

another "learning station" in their preschool classroom. In fact, for the majority of the

children, the computer area was their favorite learning area.

The present study demonstrates that the use of computer technology in preschool classrooms can have positive effects on the children's school readiness skills as well as their social development.   It also suggests that providing children with mere access to computers is not enough. Although all children in the present study became more adept computer users and showed progress in their academic readiness and social skills, children who received weekly mentoring from a technology trainer displayed significantly greater gains in all areas. The importance of providing interaction with a more competent mentor while in the act of learning a new skill is fundamental to Vygotsky's (1978) developmental theory. Within this framework, social interaction is central to cognitive change. The issue of providing competent technology mentors for young children is particularly salient for those in the lower socioeconomic strata as low-income children are more likely to have parents and teachers who are also victims of the digital divide. For example, in this study, two-thirds of the children came from homes without computers and over one-half of their teachers reported being "novice" computer users with little or no computer experience. Thus, unless technology trainers were provided, the opportunity for technology guidance from a more experienced mentor was minimal.

What was striking about this data was the unequivocal negation of the concerns expressed by the Alliance for Childhood report (Cordes & Miller, 2000) of the negative effects of computer use on children's development. According to classroom teachers and technology trainers, the computer energized student learning. Children were active participants in the learning process. The children were able to "take charge" of their learning environment. They could control the content, the difficulty level, and the pace

of the skill they were attempting to master. The success they experienced with the computer encouraged them to take more risks in other learning areas.   They became more interested in learning in general. Children acquired a host of important kindergarten readiness skills, especially in the area of emergent literacy. The computer was also a vehicle for the development of important social skills. The children became more patient and displayed greater impulse control. (After all, there is no way to rush a computer!). The children learned to share and to take turns. Opportunities for peer-to-peer mentoring encouraged a sense of competence and cooperation. Peer relationships improved. In terms of their emotional development, children's self-confidence and self-esteem increased noticeably.

Perhaps the most intriguing findings of the present study was that fact that the teachers and the technology trainers viewed the computer as the "great equalizer". That is, because the computer was "new" to so many of the children, the children who were often at a disadvantage in other areas were able to succeed (and excel) at the computer. The advantages for children with special needs were particularly evident. For example, the child with speech and language delays or whose primary language was not English could be successful without words and could practice sounding out their words without stigma. The shy child gained confidence. The overactive child and the impulsive child learned to pay attention and to stop and think. Ironically, a social condition that separates these children in one sense creates a situation which equalizes their status in another and results in positive personal change and a feeling of empowerment.

Providing technology training for these preschoolers affected the larger ecology of their social world. That is, both parents and teachers became more interested in becoming more computer literate themselves. By observing the children at the computer and using the computer with them their perceptions of the children were changed. Elkind (1985) suggests that technology has the potential to change the quality of human interactions within social systems such as family and school. Focus group data found that teachers were impressed by the children's abilities. Teachers began to appreciate a greater diversity of strengths in their students. Research from the larger Technology Project (Primavera, et al., 2001) found that when parents and children engaged in technology training together as new learners, parents came to view their children as more competent learners and parent-child relationships improved. These indirect changes in the child's ecological world result in a more positive, more reinforcing, more nurturing learning environment in which to grow.

Conclusion

It is likely that for the children and adults of the 21st Century "computer literacy" will be as crucial to educational and occupational success as traditional literacy was to their parents and grandparents in the last half of the 20th Century. The important question regarding technology in the preschool classroom is not "if it should be there" but rather "how it can and should be used?". It is likely that the negative findings regarding computer use with this age group has less to do with computer use per se and more to do with how the child's computer experience is structured. The introduction of computer technology into a young child's preschool experience should follow the guidelines as the initiation of any

new curriculum. That is, it should be developmentally appropriate and it should

be informed by the field's knowledge regarding "best practice". Developmentally

appropriate exposure to the computer provides opportunities for active

exploration and active learning, collaboration with others, and "real world"

connections to the larger academic and social environment.   Maximum benefits

are derived when, for at least some of the time, the child learns alongside a more

competent mentor.

Clearly, computer use has the potential to both positively and negatively

impact the lives of children. The issue of how best to involve young children with

computers is a complex one and requires a multidisciplinary approach including

experts from education, psychology, computer science, behavioral optometry,

orthopedics, physical therapy, etc. Only with such multidisciplinary input will

benefits be maximized and potential problems avoided.

What is perhaps most intriguing about the results from this study and data

from the larger Technology Training Project (Primavera, et al., 2001) is that

within the inequities created by the digital divide lies an opportunity to eradiate

other social stratifications that create their own brand of "haves" and "have nots".

A recurrent finding from this Project was that when children and adults are new

users of technology, previous measures of differential status are of little

consequence – the playing field is equalized. Individuals who are at a

disadvantage when it comes to other skills have an opportunity to excel as a

computer user. When children and adults who are novice users learn computer

skills together, adults come to appreciate new areas of the children's strengths

and view children as more competent learners. These types of perceptions are

likely to substantially change the nature of the adult-child interaction for the

better. It is these types of subtle "unintended consequences" that need further

exploration.

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