Digital Equity: New Findings from the Early Childhood Longitudinal Study*

Sharon Judge
Kathleen Puckett
Burcu Cabuk
University of Tennessee, Knoxville

Abstract

This study examined young children's differential access to computers in school and home and the varying conditions that affect how children experience computers. The sample consists of 9,840 public school children who attended kindergarten and first grade. Lower and higher poverty schools are about equally likely to have computers available for children when they start their formal schooling. However, the findings suggest that the digital gap starts to widen as children move into first grade. Even though children's access to most computer resources at school increased from kindergarten to first grade, children attending higher poverty schools had significantly fewer computers and software programs available. Young children's use of computers in their classrooms differed by school poverty status. (Keywords: access, equity, technology, young children.)

As computer technology becomes increasingly prevalent throughout society, concerns have been raised about reducing the "digital divide" between children who are benefiting and those who are being left behind. Initially coined in the mid 1990s to refer to unequal access to information technology (Light, 2001), the term digital divide is now generally defined as the difference in information technology use based on ethnicity and socioeconomic status. Digital divide statistics are most frequently applied to computer availability and use in schools (Swain & Pearson, 2002), and to homes with computers with access to the Internet (Fairlie, 2002). Although substantial gains have been made in the United States in reducing the disparity in access that ethnic minority and lower socioeconomic groups have experienced, other disparities based on wealth continue for the most needy students.

Digital equity is a social justice goal of ensuring that all students have access to information and communications technologies for learning regardless of socioeconomic status, physical disability, language, race, gender, or any other characteristics that have been linked with unequal treatment. Equitable access to technology resources (computers, software, connectivity) is one aspect of digital equity concerns. Other dimensions include effective use of technology for teaching and learning, access to content that is of high quality and culturally relevant, and opportunities to create new content (National Institute for Community Innovations, 2003).

In the past several years, much has been invested to bring students and educators up to speed with technology. With the passage of the 1994 Elementary and Secondary Education Act, Congress created technology programs to promote experimentation, research, and the proliferation of good ideas. The Universal Service Fund for Schools and Libraries, commonly known as the "E-Rate," pro-

vides discounts on the cost of equipment and telecommunications services to public and private schools and libraries. Public school districts across the United States have been the primary beneficiary of this legislation and have used these discounts, which range from 20% to 90% depending on economic need and rural location, to increase the infrastructure needed to make Internet connections widely available in schools. (Puma, Chaplin, & Pape, 2003). In addition, as part of the *No Child Left Behind Act of 2001* (NCLB, P.L. 107–110), the Enhancing Education Through Technology (ED Tech) program seeks to improve student academic achievement in elementary and secondary schools through the use of technology, to assist students to become technically literate by the eighth grade, and to ensure that teachers integrate technology into the curriculum to improve student achievement. Although access to technology resources is improving, details show that equitable access has not been fully achieved. For example, between 1993 and 1999, the percentage of classrooms with Internet access grew from 3% to 65%, and at the end of 2001, 99% of public schools had access to the Internet (Kleiner & Farris, 2002). However, schools with the highest poverty concentration had fewer rooms with Internet access than in schools with lower poverty concentration. Poor children and children from ethnic minorities still are more likely to come from homes without computers and Internet access (Fairlie, 2002; Puma, Chapin, & Pape, 2003; Solomon, 2002; Wilhelm, Carmen, & Reynolds, 2002). In figures reported without regard to socioeconomic levels, 28% of school inventories during 1999–2000 included much older computers, such as 286 or 386 level machines or Apple IIs, which do not have the multimedia capabilities or data handling capabilities of newer models (Meyer, 2001).

Beyond issues of access, however, are larger goals of the quality of the technology use. Details of technology use suggest that digital equity goals are still a major concern. A number of research efforts have indicated that technology access and use in U.S. schools is indeed somewhat polarized, with schools serving Black, Hispanic, and low socioeconomic status (SES) students tending to have the lowest access to, and the most remedial usages of, new technology (Becker, 2000; Dividing Lines, 2001; Wenglinsky, 1998). In contrast, Becker reports that teachers teaching lower-income students reported weekly use of computers more often than teachers teaching higher-income students. However, the nature of children's experiences using computers in school varied greatly by subject and teacher objectives, and his findings suggest that lower-income students use computers more often for repetitive practice, whereas higher-income students use computers more often for more sophisticated, intellectually complex applications.

Furthermore, the lack of consensus towards an operational definition of technology access confounds the interpretation of the results of most studies. Reports on the number of computers and connections per student or school often assume that access and availability are equivalent terminology. This particular use of access ignores the larger potential meaning of actual individual student use that is a component of digital equity concerns. Although we acknowledge the potential difference in meaning of these terms, we use the terms access and

availability interchangeably in this article. However, when reporting the number of computer resources per school or per student without regard to use, we generally use the term availability. When reporting issues related to the Internet, we use the common vernacular term access, as in "Internet access." We use the term "use" when reporting on particular software applications or incidences of use.

Even though most schools now have computers and Internet access, there is limited empirical research regarding crucial aspects of digital equity as technological availability improves. Even fewer studies have focused exclusively on the availability of computers for young children and their use of computers when they are starting formal schooling. Most studies report results for students attending either elementary, middle, or high school programs, with little description of computer availability or use in the primary grades. Although one might assume, as the technology infrastructure of schools continues to improve, that students in primary grades have increasing access to computers, few studies reflect this specific focus. Recently available data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–99 (West, Denton, & Germino-Hausken, 2000) has allowed us to capture a snapshot of the progress towards equitable technology access for primary-age children.

The purpose of this study is to describe young children's differential access to computers in school and the varying conditions that affect how they experience computers. We addressed three major research questions: (a) Are computer resources equally available to young children attending higher poverty and lower poverty schools? (b) What opportunities do young children have to use computers in their classrooms and homes? and (c) Are there differences between higher poverty and lower poverty schools in how teachers of young children use computers in their classroom?

RECOMMENDED USE OF COMPUTERS BY YOUNG CHILDREN

The National Association for the Education of Young Children's (NAEYC) Position Statement on Technology and Young Children is consistent with the goals of digital equity (NAEYC, 1996). This statement supports equitable access to computers for all children. It recognizes that equitable access for children from low-income families, for whom the school may be the primary source of computer opportunity, may necessitate providing them with increased computing opportunities. The guidelines recommend proactive strategies to ensure equity of use based on gender and access to assistive technologies for children with disabilities. Beyond equitable access, NAEYC recommends that technology be integrated into the learning environment as one of several support options. The appropriateness of computer technology depends on its salient features, the goals set for computer use, and the children who are using it. Research has shown that, depending on its features, different kinds of software lead to vastly different educational outcomes (Haugland & Wright, 1997). Most notably, studies have found that open-ended, child-directed software made a more significant difference in children's developmental gains than did drill and practice software (Haugland, 1992, 1999).

When used in a developmentally appropriate manner, computers have great potential to benefit the learning of young children. Computers can provide assistance, support, and guidance in learning new tasks in a manner that fits the learning style of young children. Computers can help young children explore a world of creative possibilities without having all the prerequisite skills; they can enjoy a story without knowing how to read it, change the ending of a story without knowing fully how to write, and build a house with limited drawing and geometry skills. A computer can provide the opportunity to access a world of people, places, and information, and most important, it can do so very quickly. In contrast, nondevelopmental software resembles electronic worksheets or flashcards, encourages more competitive behavior, and can discourage creativity and the exchange of ideas (Haugland, 1992, 1999). Computers in early childhood should be fully integrated into the overall curriculum of the classroom. Developmentally appropriate computer-based learning experiences have the potential to contribute not only to what young children learn but also to how they learn (Judge, 2002).

Developmentally appropriate use is difficult to achieve in buildings where computers are confined to computer labs or where classrooms are equipped with only one or two computers. Classrooms should be equipped with one computer for every 4 students in elementary classrooms and they should be located where social interactions with peers and teachers during computer use can be encouraged (Becker, 2000; Skeele & Stefankiewicz, 2002).

To allow children to reap the greatest benefits from using technology, the software must also be developmentally appropriate. Well-designed software engages children in a process of exploration, maintains children's interest over time, and encourages active participation rather than sitting and watching (Judge, 2001). It also should be visually engaging through the use of colorful, uncluttered, realistic graphics and sounds. In order for computers to be used in a developmentally appropriate manner, young children must have access to updated and functional equipment (Swain & Pearson, 2002). The computers that run this software must have multimedia capabilities. Machines that at the very minimum have a CD-ROM drive usually can run most of this software.

Developmentally appropriate use also includes access to Internet resources. Researchers have identified Internet sources to use with children that provide real-time access to topics of interest, access to children's literature, and other creative outlets (Skeele & Stefankiewicz, 2002). Although some individuals and groups have called for a moratorium on Internet use in elementary schools (Cordes & Miller, 2000; Light, 2001), most researchers agree that young children benefit from LAN and Internet access. Furthermore, the National Educational Technology Standards (NETS) list the ability to gather and communicate with others using telecommunications as one of ten performance indicators at the preK–2 level (ISTE, 2000).

Another important factor in effective use of computers is staff training and technology support. Teacher familiarity, confidence, and skill in choosing software and integrating technology into the curriculum are dependent on teacher training and time for self-directed exploration and learning. Due to the relative newness of computer technology, many teachers have not received adequate training to select ap-

propriate technologies and lack support to use them. It appears that the rapidly accelerating investments in computer hardware and software have not always been matched with the support and training needed by the teachers expected to improve the educational experiences of young children. Thus the mere presence of computers alone does not ensure appropriate or effective use.

Digital equity for young children, therefore, includes access to computer resources that are used in developmentally appropriate ways with teachers who have the knowledge and skills to integrate technology into meaningful activities of interest and relevance to children. Equitable use means that computers are fully integrated into a developmentally appropriate curriculum and include opportunities for interaction by virtue of placement and proximity, with relatively low computer-pupil ratios, and updated equipment with telecommunications access. Statistical data that report levels of availability and type of use among young children can indicate if classrooms are making progress towards digital equity for all groups of students. This longitudinal study describes the extent of this progress.

METHOD

The sample was drawn from the kindergarten-first grade longitudinal years of the Early Childhood Longitudinal Study, Kindergarten Class of 1998–99 (ECLS-K), a nationally representative and general purpose study on children's early education of about 22,000 public and private school children in more than 1,200 kindergarten programs, sponsored by the National Center for Education Statistics (West et al., 2000). The ECLS-K study used a multistage probability sample design. The primary sampling units were geographic areas consisting of counties or groups of counties from which 1,280 public and private schools offering kindergarten programs were selected. Each sample child was linked to his or her kindergarten teacher. Data were collected from adaptive, individually-administered child assessments, parent interviews, and teacher and school administrator questionnaires.

This study employs a subsample of ECLS-K data on public school children who attended kindergarten and first grade. The resulting subsample consists of 9,840 children in 669 pubic schools, averaging 15.2 students per school. School comparisons are based on data provided by the school principals. Schools are classified by their concentration of low-income children. Concentration of low-income children is based on the percent of the total enrollment that is eligible for free or reduced-priced lunches. Schoolwide Title I participation is used when this information is missing. The criteria used to define higher poverty and lower poverty schools are the following: (a) higher poverty schools have 50% or more of the total school enrollment eligible for free and reduced lunch and (b) lower poverty schools have less than 50% of the total school enrollment eligible for free and reduced lunch. Of this sample, 61.9% attended lower poverty schools (n = 6,093) and 38.1% attended higher poverty schools (n = 3,747). Demographic information about the children and their families is presented in Table 1. Because the ECLS-K design oversampled certain types of schools and children (private schools and Asian children), the ECLS-K child-level longitudinal design weights are employed for all analyses. Results of this study are thus generalizable to the nation's kindergarteners and first-graders and their schools.

Measures

Data were collected through parent interviews and teacher and school administrator questionnaires. School administrators and kindergarten and first-grade teachers completed paper and pencil questionnaires that asked about availability of different computer resources. School administrators also provided counts on the total number of computers in the school and the number of classrooms with different computer resources. Parents of kindergartners and first-graders provided information on whether there was a home computer that their child used and whether their child accessed the Internet from home. In addition, kindergarten and first-grade teachers indicated the frequency with which children in their classroom as a whole used computers for several instructional purposes, including to learn reading, writing, or spelling; to learn math; to learn social studies; to learn science concepts; to learn keyboard skills; to create art; for fun (games); and for Internet/local area network (LAN) access.

RESULTS

The Availability of Computers for Young Children

Almost all schools and classrooms had a variety of computer resources available to young children. (See Table 2.) During kindergarten and first grade, all public school children attended schools that had at least one computer. Ninety-four percent of children in higher poverty schools and 97% of children in lower poverty schools had computers available in kindergarten. No differences were found in availability of computers and software during the kindergarten year

Table 1: Demographic characteristics of children (N=9,840)

Characteristics	High Poverty Schools		Low Poverty Schools	
	n	*%*	*n*	*%*
Child's gender				
Male	1,950	52.0	3,150	51.7
Female	1,797	48.0	2,943	48.3
Child's race				
White	1,233	32.9	4,021	66.0
Black	1,068	28.5	530	8.7
Hispanic	933	24.9	810	13.3
Asian/Pacific Islander	307	8.2	494	8.1
Other	206	5.5	238	3.9
Family socioeconomic status level (SES)				
Low SES (Bottom 20%)	1,413	37.7	829	13.6
Middle SES (middle 60%)	2,098	56.0	3,875	63.6
High SES (Top 20%)	236	6.3	1,389	22.8
Home language of child				
Non English	824	22.0	682	11.2
English	2,923	78.0	5,411	88.8
Family poverty level				
Below poverty threshold	1,547	41.3	920	15.1
Above poverty threshold	2,200	58.7	5,173	84.9
Child with a disability	446	13.9	778	14.3

with respect to school poverty concentration. However, in first grade, children attending lower poverty schools had significantly more computers ($t = -3.62$, $p < .001$) and software ($t = -4.26$, $p < .001$) available in their schools.

   The availability of computer resources at school was also examined in terms of the school's child/computer ratio—that is, the number of children enrolled in the school divided by the total numbers of computers in the school—and the percent of classrooms in the school that had various computer resources available for student use. The child/computer ratio varied greatly across schools, with some schools having more than one computer per child to others having one computer for as many as 182 students during the kindergarten year. This range decreased during first grade (*range* = .45–100 students). The ratio of children to computers during the kindergarten year was lower in schools with higher poverty concentration (8.0 to 1 compared with 8.7 to 1 in lower poverty schools). In contrast, the ratio of children to computers during first grade was highest in schools with higher poverty concentration (7.8 to 1 compared with 7.2 to 1 in lower poverty schools). When children's access to computer resources was examined in terms of their school's child/computer ratio, no significant differences were detected across school poverty concentration for both kindergarten and first grade.

   Another benchmark for computer access is if classrooms have at least one computer for every four students (Becker, 2000). During kindergarten, 19% of

Table 2: Percent of computer resources available to kindergarten and first grade children

| | Kindergarten | | First Grade | |
| | *High Poverty* | *Low Poverty* | *High Poverty* | *Low Poverty* |
Computer Resources	%	%	%	%
Access to computers	94.3	96.5	96.2	98.6
Access to software	94.1	96.4	95.0	98.4
School computer resources:				
Computer lab	79.1	81.8	78.9	81.4
Local area networks (LAN)	78.8	81.4	83.4	89.3
CD ROM Drives	98.0	98.4	97.7	97.7
Wide Area Networks (Internet)	85.0	89.1	89.7	94.1
Teacher/Classroom resources:				
Computers used in classroom	93.8	90.0	87.6	91.6
Computer area in classroom	85.3	87.6	90.2	92.0
Teacher attended computer workshop	61.1	63.5	62.6	61.9
Home computer resources:				
Child has access to and uses a computer at home	34.7	59.8	46.4	70.9
Child has access to and uses the Internet at home	10.7	13.1	—	—

classrooms in higher poverty schools had at least one computer per four children. In contrast, only 10% of classrooms in lower poverty schools had at least one computer for every four children. Similar findings were found during first grade. Almost 23% of classrooms in higher poverty schools and 17.5% of classrooms in lower poverty schools had at least one computer per four children. Significant differences at the $p < .001$ level were found between the higher poverty and lower poverty schools for both years. Thus, higher poverty schools were more likely to have at least one computer per four children compared to lower poverty schools. Overall, these findings show that availability of computer resources at school increased from kindergarten to first grade. Changes in availability may be due not only to the change in grade level but also to the general growth in computer resources from 1999 to 2000.

In an effort to identify whether school computer resources were equally distributed to all children, the number of kindergartners and first-graders with access to various computer resources was examined in relation to school poverty concentration. A series of one-way MANOVAs was conducted with school poverty concentration as the independent variable and computers with LAN access, CD-ROM access, and Internet access as dependent variables. Significant effects, tested with Wilks' lambda, were followed with univariate ANOVAs. The main effect of school poverty concentration was significant for first grade, Wilks' lambda $F(3, 9,253) = 17.32$, $p < .001$. Univariate analyses displayed significant group differences with respect to computers with LAN access and Internet access. There were no significant group differences regarding CD-ROM access. Significant post hoc comparisons revealed that lower poverty schools reported more access to computers with LAN and Internet access. These findings are similar to those reported by Kleiner and Farris (2002).

Kindergarten and first-grade teachers' participation in computer/technology workshops during the school year did not show variation by school poverty concentration. However, a lower percentage of kindergartners in the higher poverty schools had computer areas in their classrooms than kindergartners from the lower poverty schools (85.3% vs. 87.6%). In addition, more children had computer areas in their classrooms in first grade (90.2% and 92% respectively). Even though children attending higher poverty schools continued to be less likely to have computer areas in their classrooms compared with children from lower poverty schools, no significant differences were found in availability of computer areas in classrooms with respect to school poverty concentration for both years.

The majority of schools had computer labs. (See Table 2.) There were no significant group differences regarding presence of a computer lab in the school during kindergarten and first grade. However, schools differed in the adequacy of these computer labs. School administrators were asked to rate their computer labs on a 4-point Likert-type scale (1 = *never adequate*; 4 = *always adequate*). First-grade children attending higher poverty schools had more adequate computer labs than children attending lower poverty schools ($t = 1.97$, $p < .05$). There were no significant group differences in adequacy of computer labs during kindergarten. In addition, higher poverty schools employed significantly more full-time computer specialists compared to lower poverty schools ($t = 5.76$, $p < .001$).

Children's access to and use of home computer resources were also compared by school poverty concentration. As shown in Table 2, a higher percentage of children in lower poverty schools had access to and use of home computer resources. Children's access to computers in their homes also improved as they moved from kindergarten to first grade. A repeated measures analysis of variance was used to test school poverty concentration differences on access to home computers from kindergarten to first grade. The repeated measures analysis of variance yielded statistically significant main effects for children's access to computers in their homes from kindergarten to first grade, Wilks' lambda $F(1, 8,520) = 33.51$, $p < .001$. There were no significant differences between computer access over time and school poverty concentrations. That is, the overall increases in access to and use of home computers from kindergarten to first grade were the same for both groups over the two-year period. Analysis of the subsequent univariate ANOVA found significant differences between school poverty concentration and access to home computers during kindergarten and during first grade. These results indicated that children in lower poverty schools had significantly more access to home computers during kindergarten and during first grade.

Use of Computer Resources

The majority of young children were in classrooms where computers were used to learn reading, writing, and spelling; to learn math; and for fun. (See Table 3.) The least frequent use for computers in kindergarten and first grade was for Internet access. A series of one-way MANOVAs was conducted with school poverty concentration as the independent variable and different instructional purposes to use computers in their classrooms (read/write/spell, math, social studies, science concepts, keyboard skills, create art, fun) as dependent variables. The main effect of school poverty status was significant for both kindergarten, Wilks' lambda $F(7, 8999) = 5.85$, $p < .001$ and first grade, Wilks' lambda $F(7,9253) = 5.00$, $p < .001$. Univariate analyses displayed significant group differences with respect to computers for read/write/spell, math, keyboard skills, and create art in kindergarten and read/write/spell and fun in first grade. Significant post hoc comparisons revealed that higher poverty schools

Table 3: Percent of kindergartners and first grade children that used computers in their classrooms on a weekly basis for various instructional purposes

| | Kindergarten | | First Grade | |
| | *High Poverty* | *Low Poverty* | *High Poverty* | *Low Poverty* |
Instructional Software	%	%	%	%
Read/write/spell	67.2	64.1	67.2	61.2
Math	62.9	60.6	57.4	53.7
Social studies	17.4	16.5	14.5	13.2
Science concepts	19.2	18.9	14.7	13.3
Keyboard skills	42.3	35.1	40.4	32.7
Create art	34.6	34.3	27.8	24.1
Games	59.8	60.1	50.8	51.4

used computers more for instructional purposes during kindergarten than lower poverty schools. In first grade, higher poverty schools used computers for instructional purpose significantly more for read/write/spell, whereas lower poverty schools used computers significantly more for fun.

Parents were asked questions about the frequency of their children's computer use in the home and the types of activities children were involved in when they used home computers. For children who used home computers, computer use averaged 3.7 days a week for kindergarteners and 3.3 days a week for first-graders attending higher poverty schools. Similar findings were reported for children who used home computers attending lower poverty schools (3.5 and 3.3 days respectively). No differences were found in frequency of home computer use during the kindergarten and first grade years with respect to school poverty concentration. At least 85% of children in both kindergarten and first grade who used home computers used them to learn skills or played educational games. In addition, of kindergartners who used home computers, 78% used them for art while 12% used them to access the Internet. There were no significant group differences in home computer use for various purposes.

DISCUSSION

Data revealed a variety of results in the extent of progress towards digital equity for young children. The good news is that schools serving predominantly young low-income children have computers and offer experiences using computers to enhance learning, especially in literacy and math. The inequities that still exist suggest a lessening, but not a total bridging, of the digital divide.

Nearly all young children have computers available at school. Lower and higher poverty schools are about equally likely to find computers in classrooms when children start their formal schooling, and this availability increased as the children moved into first grade. However, these findings suggest that the digital gap starts to widen as children move into first grade. Even though the availability of computer resources at school increased from kindergarten to first grade, higher poverty schools had significantly fewer computers and software programs.

In contrast, the number of computers per student was roughly the same with no significant differences between higher and lower poverty schools. If one were to look at accepted benchmarks for computer to student ratios, (1 to 4), a slightly better percentage of higher poverty schools met this goal than lower poverty schools in kindergarten, suggesting some attention to decreasing the disparities in availability of resources. Few schools, however, actually met this standard, regardless of poverty concentration.

CD-ROM technology was equally available among higher and lower poverty schools although lower poverty schools generally provide more widespread Internet and LAN access. The availability of LAN and Internet services increased between kindergarten and first grade, suggesting that infrastructure improvements continue in higher and lower poverty schools. Actual Internet use among young children, however, was minimal for both groups.

The opportunities young children have to use computers varied widely. More than half of all young children attended classrooms where computers were used

for various instructional purposes at least once a week. However, young children's use of computers in their classrooms differed by school poverty status. When compared to use in lower poverty settings, higher poverty schools used computers significantly more for instruction during kindergarten and significantly less for games or fun during first grade. This corroborates the findings of Becker (2000), who reported more frequent use of computers by teachers of low-income students. Although the data do not describe the instructional use or the type or quality of the software, differing use by poverty concentration may indicate a concern. Progress in computer availability does not always insure equitable use, and further study may be needed to determine if children from higher poverty schools are using computers in developmentally appropriate ways to study the source of these reported differences (Kleiman, 2000). The high percentage of schools in both groups reporting the presence of computer labs in the school—an apparent conflict with recommendations regarding developmentally appropriate use of technology resources—is of further concern.

More than 60% of kindergarten and first-grade teachers attended a computer/technology workshop during the school year. Because of the rapid proliferation of computers in schools during the last few years, many teachers feel uncomfortable using computers and are unaware of the teaching and learning pedagogies that computers and the Internet are able to support. Professional development is a critical ingredient in effective use of technology in the classroom. These findings indicate that many teachers are not receiving the professional development opportunities to better prepare them to use technology in their teaching.

Although computer access at home is increasing, schools remain an important initial entry point of access, especially among low poverty children. Although children's access to home computer use increased from kindergarten to first grade for both higher poverty and lower poverty children, higher poverty children still had less access to home computers for both years. On a more positive note, among children who did have access to home computers, the frequency and purpose of use did not differ by school poverty concentration. Both groups reported frequent use of home computers to learn skills or play educational games.

A major limitation of this study is the lack of specific information on the quality of young children's computer use or the specific software children are using at school and in their homes. As a secondary data analysis, our construction of the use of computer resources measures is confined to the questions that were already included in the teacher survey. The nature of the questions and the way they were asked may not be ideal for the investigation of computer equity. For example, the teacher questionnaires only asked about the frequencies of computer use for different instructional purposes in their classroom as a whole. We do not know how much time children spent using computers. A second limitation is that although the school and classroom indicators provided the overall level of resources available to students in the school they attended, they do not provide direct information on whether certain computer resources were actually available to the sampled children. A third limitation is that young

children's access to and use of computer resources are compared from kindergarten in the spring of 1999 to the first grade in the spring of 2000. Differences that are detected between the two grade levels may be due to children's change in grade level. Differences found across grade levels may also be credited to the increase of computer resources from 1999 to 2000. For instance, the proportion of instructional rooms with Internet access in U.S. public schools rose, from 64% in 1999 to 77% in 2000 (Cattagni & Farris, 2001).

CONCLUSION

Our findings provide evidence that American public schools are making progress towards digital equity for all groups of students. However, the average student-to-computer ratio of 8.4 to 1 in kindergarten and 7.4 to 1 in first grade is still much higher than the recommended ratio. Thus, there is still a real need to decrease the student-to-computer ratio for young children. In addition, on-going and exemplary professional development with respect to technology use in the classroom may help diminish this gap. Becker (2000) supports this idea when he states, "Teachers who are prepared to use computers tend to demand greater access, so the correlation between having classroom access to computers linked to the Internet and using those computers more extensively is not surprising" (pp. 53–54). Secondary sources of data from higher and lower poverty schools show differences that may be contrary to recommendations for technology use among young children. And although areas of concern emerged in teacher training and use of computer labs, these areas are a concern for both higher and lower poverty schools and point to areas needing improvement for all young children. Future longitudinal studies with the ECLS-K can examine if this progress of diminishing the digital divide continues over time. Future research could also examine the relationships between children's access to and use of computers in different settings with their development and achievement.

Contributors

Sharon Judge is an associate professor in the Department of Theory and Practice in Teacher Education at the University of Tennessee, Knoxville. She is co-author of *Assistive Technology for Young Children with Disabilities* as well as numerous articles on technology integration. Her research interests include teacher education, technology integration, and young children with disabilities. (Address: Sharon Judge, A 416 Claxton Complex, Knoxville, TN, 37996-3442; shl@utk.edu.)

Kathleen Puckett is an associate professor in the Department of Theory and Practice in Teacher Education at the University of Tennessee, Knoxville. Her research interests include use of assistive technology in general education settings and use of technology in pre-service teacher education. (Address: Kathleen Puckett, 419 Claxton Complex, Knoxville, TN, 37996-3442; kpuckett@utk.edu.)

Burcu Cabuk is a doctoral student in Early Childhood Education at the University of Tennessee, Knoxville. Her research interests include teacher education and the use of technology in early childhood education. (Address: Burcu Cabuk, A 423 Claxton Complex, Knoxville, TN, 37996-3442; burcu@utk.edu.)

References

Becker, H. J. (2000). Who's wired and who's not: Children's access to and use of computer technology. *The Future of Children: Children and Computer Technology, 10*(2), 44–75.

Cattagni, A., & Farris, E. (2001). *Internet access in U.S. public schools and classrooms: 1994–2000* (NCES 2001-071). U.S. Department of Education, Washington, DC: National Center for Education Statistics.

Cordes C., & Miller, E. (2000). *Fool's gold: A critical look at computers in childhood*. College Park, MD: Alliance for Childhood. Retrieved September 11, 2003, from http://www.allianceforchildhood.net/projects/computers/computers_reports_fools_gold_contents.htm

Dividing Lines (2001, May 10). *Education Week*, *20*, 12–13.

Fairlie, R. (2002). *Race and the digital divide*. Chicago IL: Joint Center for Poverty Research.

Haugland, S. (1992). Effects of computer software on preschool children's developmental gains. *Journal of Computing in Childhood Education, 2*, 3–15.

Haugland, S. W. (1999). What role should technology play in young children's learning? Part 1. *Young Children 54*(6), 26–31.

Haugland, S., & Wright, J. (1997). *Young children and technology: A world of discovery*. Needham Heights, MA: Allyn and Bacon.

International Society for Technology in Education [ISTE] (2002). *National Educational Technology Standards for Students*. Eugene, OR: Author.

Judge, S. L. (2001). Integrating computer technology within early childhood classrooms. *Young Exceptional Children, 5*(1), 20–26.

Judge, S. L. (2002). Selecting developmentally appropriate software. *Children and Families, 16*(3), 18–19.

Kleiman, G. M. (2000, April-June). Myths and realities about technology in K–12 schools. *LNT Perspectives: The Online Journal of the Leadership and the New Technologies Community*, *14.* Retrieved September 16, 2003, from http://www.edc.org/LNT/news/Issue14/feature1.htm

Kleiner, A. & Farris, E. (2002). *Internet access in U.S. public schools and classrooms: 1994–2001* (NCES 2002-018). U.S. Department of Education, Washington, DC: National Center for Education Statistics.

Light, J. (2001). Rethinking the digital divide. *Harvard Educational Review*, *71*(4), 709–735.

Meyer, L. (2001). New challenges: Overview of state data tables. *Education Week* on the Web. Retrieved September 2, 2003 from http://www.edweek.org/sreports/tc01/tc01article.cfm?slug=35challenges.h20

National Association for the Education of Young Children (1996). NAEYC Position statement on technology and young children: ages three through eight. *Young Children*, *51*(6), 11–16.

National Institute for Community Innovations (2003). The five dimensions of digital equity. Retrieved August 29, 2003 from http://digitalequity.edreform.net/

No Child Left Behind Act of 2001, Pub. L. No. 107-110, 115 Stat. 1425. (2002).

Puma M., Chapin, D., & Pape, A. (2003). *E-Rate and the digital divide: A preliminary analysis from the integrated studies of educational technology*. Washington DC: The Urban Institute.

Solomon, G. (2002). Digital equity: It's not just about access anymore. *Technology & Learning, 22*, 18–26.

Skeele, R. & Stefankiewicz, G. (2002). Blackbox in the sandbox: The decision to use technology with young children with annotated bibliography of Internet resources for teachers of young children. *Educational Technology Review, 10*(2), 79–95.

Solomon, G. (2002). Digital equity: It's not just about access anymore. *Technology & Learning, 22*(9) 18–26.

Swain, & Pearson, (2002). Educators and technology standards: influencing the Digital Divide. *Journal of Research on Technology in Education, 34*,(3) 326-336.

Thouvenelle, S. (2002). Do computers belong in early childhood settings? Retrieved September 11, 2003 from http://www.earlychildhood.com/Articles/index.cfm?FuseAction=Article&A=23

Wenglinsky, H. (1998). *Does it compute?: The relationship between educational technology and student achievement in mathematics* (Policy Information Report). Princeton, NJ: Educational Testing Services. Available: http://ftp.ets.org/pub/res/technolog.pdf.

West, J., Denton, K., & Germino-Hausken, E. (2000). *America's kindergartners. Findings from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–99, Fall 1998*. NCES 2000-070. Washington, DC: National Center for Education Statistics.

Wilhelm, T., Carmen, D., & Reynolds, M. (2002). Connecting kids to technology: Challenges and opportunities. *Kids Count Snapshot*. Retrieved September 11, 2003 from http://www.aecf.org/publications/data/snapshot_june2002.pdf