

# Does Home Internet Use Influence the Academic Performance of Low-Income Children?

Linda A. Jackson, Alexander von Eye, Frank A. Biocca, Gretchen Barbatsis, Yong Zhao,  
and Hiram E. Fitzgerald  
Michigan State University

HomeNetToo is a longitudinal field study designed to examine the antecedents and consequences of home Internet use in low-income families (<http://www.HomeNetToo.org>). The study was done between December 2000 and June 2002. Among the consequences considered was children's academic performance. Participants were 140 children, mostly African American (83%), mostly boys (58%), and most living in single-parent households (75%) in which the median annual income was \$15,000 (U.S. dollars) or less. Average age was 13.8 years. Ages ranged between 10 and 18 years, Internet use was continuously recorded, and multiple measures of academic performance were obtained during the 16-month trial. Findings indicated that children who used the Internet more had higher scores on standardized tests of reading achievement and higher grade point averages 6 months, 1 year, and 16 months later than did children who used it less. Older children used the Internet more than did younger children, but age had no effect on the nature or the academic performance benefits of Internet use. Implications for the digital "use" divide are discussed.

*Keywords:* Internet use, academic performance, technology

Decades of research has focused on the issue of whether using computers facilitates learning, typically measured as school performance. After reviewing dozens of studies of school learning with computer-based technology, including five meta-analytic reviews, Roschelle and colleagues came to the less-than-satisfying conclusion that the findings are inconclusive (Roschelle, Pea, Hoadley, Gordon, & Means, 2000). For example, one meta-analytic review of over 500 studies (kindergarten through twelfth-grade students) found positive effects of computer tutoring applications on achievement test scores. However, other uses of the computer, such as simulations and enrich-

ment applications, had no effects (Kulik, 1994). Still other findings suggest that the benefits of computer-based instruction are clearer for mathematics and science than they are for other subjects. For example, a study by the Educational Testing Service found that using computers to engage higher-order thinking skills was related to better school performance in mathematics by fourth and eighth graders (Wenglinsky, 1998).

Roschelle et al. (2000) offered three explanations for the equivocal findings with respect to computer-based instruction and school performance. First, variability in hardware and software among schools participating in the research may explain the equivocal findings. Second, the failure of schools to accompany technology use with concurrent reforms in the other areas, such as curriculum and teacher professional development, may explain the failure to find beneficial effects of technology use on academic performance. Third, the lack of rigorous, structured longitudinal studies may explain the failure to find positive effects of computer-based instruction, as well as information technology use in general, on academic performance. Roschelle and colleagues suggest that positive effects are most likely to emerge when technology is used to support the four fundamentals of learning: active engagement, participation in groups, frequent interaction and feedback, and connections to real-world contexts.

Subrahmanyam and colleagues reviewed the research on computer use and cognitive skills, focusing on a broad array of cognitive competencies but particularly on visual intelligence skills, such as spatial skills and iconic and image representation skills (Subrahmanyam, Kraut, Greenfield, & Gross, 2000; Subrahmanyam, Greenfield, Kraut, & Gross, 2001). These authors conclude that computer use does contribute to cognitive skills, specifically to visual skills. For example, playing certain types of computer games, namely action games that involve rapid move-

---

Linda A. Jackson, Alexander von Eye, and Hiram E. Fitzgerald, Department of Psychology, Michigan State University; Frank A. Biocca, and Gretchen Barbatsis, Department of Telecommunications, Information Studies, and Media, Michigan State University; Yong Zhao, Department of Counseling, Educational Psychology, and Special Education, Michigan State University.

This research was supported by National Science Foundation–Information Technology Research Grant NSF-ITR085348, "HomeNetToo: Motivational, Affective and Cognitive Antecedents and Consequences of Home Internet Use in Low-Income Families: Understanding the Digital Divide and the Internet Paradox," awarded to Linda A. Jackson.

We are grateful to the 12 graduate students and 25 undergraduates who assisted with home visits, technical support, data collection, and other aspects of the project. We are also grateful to participants in the NSF-sponsored workshop titled, "Domestic Impact of Information and Communication Technology," Estes Park, CO, June 5–8, 2003. Their comments and enthusiasm contributed greatly to the development of this article. Special thanks go to Sonia Livingstone and Keith Hampton for comments on a draft of this article, to Robert Kraut for organizing the workshop, and to Sara Kiesler, who encouraged this work.

Correspondence concerning this article should be addressed to Linda A. Jackson, Department of Psychology, Michigan State University, East Lansing, MI 48824. E-mail: [jackso67@msu.edu](mailto:jackso67@msu.edu)

ment, imagery, intense interaction, and multiple activities occurring simultaneously, improves visual intelligence skills. As the authors point out, these skills “provide ‘training wheels’ for computer literacy” and are “especially useful in the fields of science and technology, where proficiency in manipulating images on a screen is increasingly important” (Subrahmanyam et al., 2000; p. 128). However, they also note that, “computer game playing can enhance a particular skill only if the game uses that skill and if the child’s initial skill level has matured to a certain level” (p. 128). Moreover, “. . . much of the existing research on computer games has measured effects only immediately after playing, and thus does not address questions about the cumulative impact of interactive games on learning” (p. 128).

Other findings point to a relationship between technology use and academic performance, although causal relationships have been difficult to establish (Blanton, Moorman, Hayes, & Warner, 1997; Cole, 1996; Rocheleau, 1995). Several studies show that the presence of educational resources in the home, including computers, is a strong predictor of academic success in mathematics and science (National Center for Educational Statistics, 2000). Having a home computer has been associated with higher test scores in reading, even after controlling for family income and other factors related to reading test scores (Atwell, 2000). Still other findings indicate that participating in a networked community of learners improves educational outcomes for at-risk children (Cole, 1996; Project TELL, 1990–1997). Some researchers have even suggested that recent nationwide increases in nonverbal intelligence test scores may be attributable to “exposure to the proliferation of imagery in electronic technology” (Subrahmanyam, et al., 2000, p. 128).

Overall, whether using computer-based technology contributes to children’s academic performance remains uncertain (Shields & Behrman, 2000). Available evidence suggests that having a home computer is linked to somewhat better academic performance, although most studies fail to control for factors that covary with having a home computer (e.g., parental income and education). The effects of computer-based school and after-school activities are unclear, although favorable effects have been observed under some circumstances (e.g., when a supportive learning environment exists; Project TELL, 1990–1997). Even more uncertain is whether using the Internet at home has positive or negative effects on academic performance, such as school grades and standardized tests of achievement (National Science Foundation Report [NSF] Report, 2001). Overall, based on evidence of positive effects of using computer-based technology on academic performance, the following hypothesis was formulated:

*Hypothesis 1.* Greater home Internet use will be associated with better academic performance in the months that follow than will less home Internet use.

Also of interest in the HomeNetToo project was the frequency and nature of low-income children’s home Internet use.<sup>1</sup> Numerous surveys have attempted to measure the frequency of children’s Internet use—the length of time children spend online. Estimates vary widely, depending on how Internet use is measured (e.g., self-report, automatically recorded), the ages of children sampled, when data were collected (i.e., year of the study), and how Internet use is defined (e.g., length of time online, frequency of use). At one extreme are estimates that children spend approximately 1

hour a day online (Turow & Nir, 2000). At the other extreme are estimates that children spend only 3 hours a week using the Internet (Kraut, Scherlis, Mukhopadhyay, Manning, & Kiesler, 1996; Stanger & Gridina, 1999; Woodward & Gridina, 2000). These findings contrast with popular opinion that America’s children are spending a great deal of time online (e.g., Kids Count Snapshot, 2002; Kraut et al., 1996; NSF Report, 2001; Pew Internet & American Life Project, 2000a, 2002; Stanger & Gridina, 1999; Tapscott, 1998; UCLA Internet Report, 2000, 2001, 2003; Woodward & Gridina, 2000).

Other research examined the nature of children’s Internet use—what they actually do when they go online. Once again, findings vary, depending on the same factors that influence estimates of the frequency of Internet use as previously discussed (e.g., ages of children sampled). Some studies find that children’s primary use of the Internet is for schoolwork, specifically searching the Web for information needed for school projects (Kraut et al., 1996; NSF Report, 2001; Pew Internet & American Life Project, 2002; Turow, 1999; Turow & Nir, 2000; Valkenburg & Soeters, 2001). The second most common use of the Internet is to communicate with peers using e-mail, instant messaging, and chat rooms (Kraut et al., 1996; Turow, 1999). However, the extent of children’s Internet use for communication is unclear, in part, because few studies have recorded actual use (versus self-reported use) and, in part, because studies are so few.

Gross (2004), using the diary report of upper-middle-class adolescents, found that the extent to which the Internet was used for communication was dependent on the number of acquaintances, family, and friends online. Communication was the number one use of the Internet in Gross’s study, a finding that has appeared consistently in more recent studies using upper-middle-class adolescents (Pew Internet & American Life Project, 2002). Less clear is whether this finding was true in 2000 for poor adolescents and whether it was or still is true of younger children. Conceivably, younger children may use the Internet more for information gathering than they do for communication.

Based on the limited research available about the frequency and nature of children’s Internet use, the following hypotheses were formulated:

*Hypothesis 2.* Children will spend between 3 hours weekly and 1 hour daily using the Internet at home.

*Hypothesis 3.* The Internet will more often be used for information than for communication.

Another interest of the HomeNetToo project is the relationship between children’s sociodemographic characteristics and their Internet use. Previous research on these relationships has focused almost exclusively on adults. Findings for adults indicate race and age differences in Internet use (Jackson, Ervin, Gardner, & Schmitt, 2001a; Norris, 2001; U.S. Department of Commerce,

<sup>1</sup> A variety of motivation, affective, and cognitive antecedents and consequences of home Internet use were assessed in surveys completed at pretrial, 1 month, 3 months, 9 months, and posttrial (i.e., 16 months).

Internet Reports, 1995, 1997, 1999, 2000, 2002).<sup>2</sup> African Americans use the Internet less than do European Americans; younger adults use the Internet more than do older adults. Gender differences in Internet use, though prevalent globally (Norris, 2001), have decreased dramatically in the United States. In 1995, approximately 95% of Internet users were men and boys. By 2002, one half of all users were woman and girls (U.S. Department of Commerce, Internet Reports, 1995, 2002). Researchers have attributed this gender shift to the proliferation of Internet communication tools that have attracted women and girls to it (Roberts, Foehr, Rideout, & Brodie, 1999; Subrahmanyam et al., 2001). In support of this view, studies indicate that women are more likely than men are to use the Internet for communication (Jackson, Ervin, Gardner, & Schmitt, 2001b).

Whether sociodemographic characteristics influence children's Internet use is unclear from existing research. Race differences in children's Internet use have not been examined, especially when access to the Internet is not an issue (i.e., within socioeconomic groups). Among teens, some evidence suggests that African Americans use the Internet less than do European Americans (Hoffman & Novak, 1998; Jackson et al., 2001a; Kraut et al., 1996). Some additional evidence asserts that older children use the Internet more than do younger children, especially for communicating with peers (Pew Internet & American Life Project, 2002; Turow & Nir, 2000). Studies of gender and children's Internet use are sparse, and findings are mixed. One study found gender parity in all Internet activities except the number of Web sites visited: boys (ages 8 to 13) visited more Web sites than did girls the same age (Roberts et al., 1999). Another study found that, although teenage girls used the Internet less than did teenage boys, they were more likely than boys were to use e-mail (56% of the girls versus 43% of the boys; Kraut et al., 1996). Based on existing research, the following hypotheses were formulated:

*Hypothesis 4.* African-American children and younger children will use the Internet less than will European American children and older children, respectively.

*Hypothesis 5.* Girls will use the Internet's communication tools (e.g., e-mail) more than will boys; boys will use the Internet's information tools (e.g., Web pages) more than will girls.

We also explored relationships among age, Internet use, and academic performance. Two questions were of particular interest. First, does age influence the nature of Internet use such that younger participants use the Internet more for information whereas older participants (i.e., adolescents) use it more for communication? Second, are the effects of Internet use on academic performance, if any, similar across the age range considered in this research (i.e., age 10 to 18 years)? Alternatively, does any evidence exist of a developmentally "sensitive" period during which Internet use has the greatest impact on academic performance?

## Methods

### Participants and Procedures

Participants in the HomeNetToo project were 140 children residing in a midsize urban community in the Midwestern United States. Demographic

characteristics of adult participants are described elsewhere (Jackson et al., 2004). Demographic characteristics of adult participants are described elsewhere (Jackson et al., 2004). Participants were recruited at meetings held at the children's middle school and at the Black Child and Family Institute, Lansing, MI. Requirements for participation were that the child be eligible for the federally subsidized school lunch program, that the family have a working telephone line for the previous 6 months, and that the family never had home Internet access. Participants agreed to have their Internet use automatically and continuously recorded, to complete surveys at multiple points during the project, and to participate in home visits. In exchange, the households received home computers, Internet access, and in-home technical support during the Internet recording period (i.e., 16 months). At the end of the project, participants kept their computers and were assisted in locating inexpensive Internet service.

As indicated earlier, children were primarily African American (83%), primarily boys (58%), and primarily living in single-parent households (75%) in which the median annual income was \$15,000 or less (49%). Average age was 13.8 years ( $SD = 1.95$ ), median age was 13 years, and modal age was 12 years. Ages ranged from 10 to 18 years, although nearly three-quarters of participants (71%) were between 12 and 14 years of age.

### Measures

*Internet use.* Four measures of Internet use that were automatically and continuously recorded for 16 months for each participant are considered in this report.<sup>3</sup> The measures are time online (minutes per day), number of sessions (logins per day), number of domains visited (per day), and number of e-mails sent (per day). Some examples of domains visited by participants are <http://www.anygivensunday.net> (entertainment), <http://www.senate.gov> (government information), and <http://www.kcts.org> (news and current events). Internet use measures were divided into five time periods, three corresponding to survey administration points plus half-year and 1-year points. The time periods were: Time 1 (1 to 3 months), Time 2 (4 to 6 months), Time 3 (7 to 9 months), Time 4 (10 to 12 months), and Time 5 (13 to 16 months). Latent linear growth curve analysis was used to evaluate time-related changes in Internet use and academic performance.

*Academic performance.* Participants' grade point averages (GPAs) and scores on the Michigan Educational Assessment Program (MEAP) tests of reading and mathematics achievement were obtained directly from the local school district (with parental permission). MEAP tests are standardized tests of known (high) reliability that Michigan educators use to inform decisions regarding educational policy and expenditures. GPAs were obtained for Fall 2000 (the semester before the project began), Spring 2001 (after 6 months of project participation), Fall 2001 (after 1 year of project participation), and Spring 2002 (the semester the project ended [April 2002]). MEAP scores were obtained for 2001 (for tests taken after 5 months of project participation) and 2002 (for tests taken 1 month after the 16-month project ended).

## Results

### Academic Performance and Internet Use

Descriptive statistics for measures of Internet use, GPA, and percentile ranks on the MEAP tests of reading and mathematics achievement are presented in Tables 1, 2, and 3, respectively. *Hypothesis 1* states that greater Internet use will be associated with

<sup>2</sup> Although socioeconomic status has consistently been related to Internet use, our sample was intentionally homogeneous with regard to this factor.

<sup>3</sup> A total of 20 measures of Internet use were recorded for each participant.

Table 1  
*Frequency and Duration of Children's Internet Use Per Day*

	Time online (minutes)	Number of sessions (logins)	Number of domains visited	Number of e-mails sent
Time 1 (1 to 3 months)				
Mean	27.09	.75	8.69	.10
Median	12.57	.38	3.95	.00
SD	37.64	.95	11.11	.57
Time 2 (4 to 6 months)				
Mean	29.70	.73	12.41	.10
Median	11.73	.34	6.17	.00
SD	41.15	.99	15.51	.48
Time 3 (7 to 9 months)				
Mean	27.41	.60	10.45	.10
Median	8.89	.23	4.69	.00
SD	41.04	.91	13.65	.63
Time 4 (10 to 12 months)				
Mean	26.87	.48	8.96	.10
Median	11.20	.26	5.30	.00
SD	46.41	.71	11.11	.62
Time 5 (13 to 16 months)				
Mean	25.63	.45	9.27	.16
Median	9.05	.21	5.33	.00
SD	48.23	.69	12.14	1.51

Note. *N*s varied from 138 to 143. All measures were automatically recorded. SD = standard deviation.

better academic performance in the months that follow. Several steps were taken to evaluate this hypothesis.

First, race, age, and gender differences in Internet use and academic performance were examined to determine whether any of these sociodemographic characteristics needed to be controlled in the analyses to predict academic performance from each measure of Internet use (in separate analyses).<sup>4</sup> Second, stepwise regression analyses were used to predict academic performance from Internet use during the preceding time period. Third, latent linear growth curve analysis was used to model relationships between Internet use and academic performance.

Consistent with *Hypothesis 4*, African-American children and younger children used the Internet less than did European American children and older children, respectively. However, no gender differences in Internet use were noted, contrary to *Hypothesis 5*. Additional analyses indicated that African-American children had

Table 2  
*Mean Grade Point Averages (GPAs)*

	Fall 2000	Spring 2001	Fall 2001	Spring 2002
N	70	107	108	93
Mean	2.00	2.03	2.06	2.05
SD	1.02	.94	.89	1.09

Note. Grade point average ranged from 0.0 to 4.0.

Table 3  
*Percentile Ranks on Standardized Tests of Academic Achievement*

	2001			2002		
	N	Mean	SD	N	Mean	SD
Reading Comprehension	95	31.85	28.03	75	35.03	29.72
Reading Total Score	95	31.93	28.55	74	33.65	28.34
Mathematics Comprehension	80	32.45	25.69	50	33.60	23.30
Mathematics Total Score	91	29.15	24.85	73	30.53	25.82

Note. Tests were the Michigan Educational Assessment Program (MEAP) tests.

lower GPAs and standardized test scores than did European American children ( $ps < .05$ ) but that age and gender were unrelated to academic performance. Thus only race was controlled in the analyses to predict academic performance from Internet use.

Regression analyses were used to predict GPA from Internet use during the preceding time period. Specifically, to predict GPA in Spring 2001, measures of Internet use during the first 6 months of the project were used (i.e., Time 1 and Time 2, combined [January 1, 2001, to June 30, 2001]). To predict GPA in Fall 2001, measures of Internet use during the preceding 6 months were used (i.e., Time 3 and Time 4 combined [July 1, 2001, to December 31, 2001]). To predict GPA in Spring 2002, measures of Internet use at Time 5 were used (i.e., January 1, 2002, until the end of the project, April 30, 2002).

Results of these analyses indicated that, after controlling for race (step 1), Internet use did not predict GPA obtained after the first 6 months of the project (i.e., Spring 2001). However, Internet use did predict GPA obtained after 1 year of home Internet access (i.e., Fall 2001,  $\Delta F[3, 96] = 3.09, p < .05$ ), and at the end of the 16-month trial (i.e., Spring 2002,  $\Delta F[4, 76] = 2.88, p < .05$ ). More Internet sessions were associated with higher GPAs.

To predict performance on standardized tests of academic achievement (i.e., MEAP percentile ranks) in Spring 2001, measures of Internet use during the first 6 months of the project were used (i.e., Time 1 and Time 2, combined [January 1, 2001, to June 30, 2001]). To predict MEAP performance in Spring 2002, measures of Internet use at Time 5 (January 1, 2002, to April 30, 2002) were used.

Results of these regression analyses indicated that Internet use during the first 6 months of the project predicted reading comprehension and total reading scores obtained at the end of that time period (i.e., Spring 2001,  $\Delta F[3, 86] = 2.59, 2.83$ , respectively,  $ps < .05$ ). More time online was associated with higher reading comprehension and total reading scores. Similarly, Internet use during the last semester of the project (Time 5) predicted reading comprehension and total reading scores obtained at the end of that semester (i.e., Spring 2002,  $\Delta F[3, 58] = 2.86, 2.96$ , respectively,  $ps < .05$ ). More Internet sessions were associated with higher reading scores. Mathematics scores could not be predicted from Internet use, regardless of which time period and which measure of Internet use was considered.

<sup>4</sup> Because Internet use measures were highly skewed, log transformations were used in all subsequent analyses.



We also examined whether academic performance predicted Internet use rather than the reverse. Support for the latter would undermine a causal role of Internet use in changes in GPA. Children's GPAs for Fall 2000 (i.e., before the project began) were used to predict Internet use at Time 1, GPAs for Spring 2001 were used to predict Internet use at Time 3, and GPAs for Fall 2001 were used to predict Internet use at Time 5. In none of these analyses did GPA predict subsequent Internet use.

Similar analyses were performed to determine whether performance on standardized tests predicted subsequent Internet use rather than the reverse. Findings indicated that scores on the MEAP tests of reading achievement obtained in Spring 2001 did not predict Internet use during the time period that followed (i.e., Time 3), regardless of which Internet use measure was considered in the analyses (e.g., time online, number of session). Taken together with findings for GPA just discussed, these null effects support the view that Internet use plays a causal role in academic performance rather than academic performance playing a causal role in Internet use.

Thus results of the regression analyses indicate that children who used the Internet more subsequently had higher GPAs and higher scores on standardized tests of reading achievement than did children who used the Internet less. The reverse was not true. Children who had higher GPAs and higher standardized test scores did not subsequently use the Internet more than did children who had lower GPAs and test scores.

Regression analyses were used to examine whether age influenced the effects of Internet use on academic performance. Thus only those measures of academic performance for which Internet effects were observed were considered in these analyses (i.e., GPA in Fall 2001, GPA in Spring 2002, MEAP reading comprehension and MEAP total reading scores in Spring 2001 and Spring 2002), and only those measures of Internet use that produced significant effects on academic performance were considered (i.e., number of sessions for GPA effects in Fall 2001 and Spring 2002 and MEAP reading score changes [comprehension and total scores] in Spring 2001 and time online for MEAP reading score changes [comprehension and total scores] in Spring 2002). Race was controlled in all of these analyses.

Results of the regression analyses indicated that age did not contribute to the prediction of GPA after 1 year of home Internet access ( $\Delta F[1, 97] = 0.09, p < .77$ ) or at the end of the 16-month trial ( $\Delta F[1, 77] = 1.44, p < .23$ ) after the effects of race and Internet use were considered. Results also showed that age was not a significant predictor of standardized test scores in reading after 1 year (MEAP reading comprehension,  $\Delta F[1, 88] = 0.11, p < .74$ ; MEAP reading total,  $\Delta F[1, 88] = ns, p < .99$ ) or at the end of the 16-month trial (MEAP reading comprehension,  $\Delta F[1, 59] = ns, p < .99$ ; MEAP reading total,  $\Delta F[1, 59] = 0.03, p < .86$ ) after the effects of Internet use and race were taken into account.

### *Frequency and Nature of Children's Internet Use*

According to *Hypothesis 2*, children will spend between 3 hours per week and 7 hours per week (1 hour per day) using the Internet. Averaging across the 16-month trial, HomeNetToo children spent approximately 27 minutes per day online (see Table 1), at the low end of the broad range predicted by *Hypothesis 2*. Children participated in 0.6 sessions per day, suggesting that they did not logon daily, and

visited approximately 10 domains per day. Children sent very few e-mail messages (less than one per week). Thus, consistent with *Hypothesis 3*, HomeNetToo children were more likely to use the Internet for information gathering than they did for communication.

### *Sociodemographic Characteristics and Internet Use*

As previously indicated, consistent with *Hypothesis 4*, African-American children and younger children used the Internet less than did European-American children and older children, respectively. Contrary to *Hypothesis 5*, no gender differences were noted in Internet use. Thus girls were no more likely than boys were to use the Internet's communication tools; boys were no more likely than girls were to use the Internet's information tools.

Age effects on Internet for communication versus information purposes were evaluated in regression analyses to predict e-mail use at each time period from participants' age (controlling for race). No effects of age were noted in any of these analyses ( $0.12 < \Delta F < 0.82, ns$ ).

## Discussion

Children who used the Internet more had higher GPAs after 1 year and higher scores on standardized tests of reading achievement after 6 months than did children who used it less. Moreover, the benefits of Internet use on academic performance continued throughout the project period. Children who used the Internet more during the last 4 months of the project had higher GPAs and standardized test scores in reading than did children who used it less. Internet use had no effect on standardized test scores of mathematics achievement.

Previous research has produced equivocal findings with respect to the effects of information technology use, specifically computer use, on cognitive outcomes (Shields & Behrman, 2000). At best, some evidence suggests a positive relationship between computer game playing and visual spatial skills (Subrahmanyam et al., 2000, 2001) and between owning a home computer and school performance, although the causal nature of the latter relationship has yet to be established (Blanton et al., 1997; Cole, 1996; National Center for Educational Statistics, 2000; Rocheleau, 1995). Whether Internet use contributes to children's academic performance has, until now, never been systematically investigated (NSF Report, 2001). Thus, until now, no evidence exists that using the Internet actually improves academic performance, despite optimism surrounding the Internet as a tool to level the educational playing field (e.g., Kids Count Snapshot, 2002).

Why did Internet use enhance HomeNetToo children's academic performance, specifically, their reading performance? One possibility is that children who spent more time online were also spending more time reading compared with their unconnected peers. HomeNetToo children logged on primarily to surf the Web. Web pages are heavily text based. Thus, whether searching for information about school-related projects or searching for information about personal interests and hobbies (e.g., rock stars, movies), children who were searching the Web more were reading more, and more time spent reading may account for improved performance on standardized tests of reading and for higher GPAs, which depend heavily on reading skills. The absence of Internet use effects on mathematics performance is consistent with this

view. Web pages do not typically engage mathematics skills. New research is needed to establish the mediational role of reading in the relationship between Internet use and academic performance.

Another subject for future research is whether Internet use has a similar positive impact on the academic performance of all children. Children in the HomeNetToo project were performing well below average in school, as measured by both GPAs and standardized tests scores. Possibly, the academic performance benefits of Internet use are limited to children in this performance range. Children whose academic performance is average or above average may not only fail to show similar benefits of Internet use, but may also show decrements in academic performance with more time online. Whatever the results of future research may be, our findings suggest that the implications of the "digital divide" in Internet use may be more serious than was initially believed. One possibility may be that children most likely to benefit from home Internet access—poor children whose academic performance is below average—are the very children least likely to have home Internet access. Additional research is needed to determine whether Internet use has similar, different, or no effect for middle-class and upper-middle-class children and for low-income children with average or above-average performance in school.

Children in the HomeNetToo project used the Internet approximately 30 minutes a day, at the low end of the broad range suggested by previous research (Kraut et al., 1996; Stanger & Gridina, 1999; Woodward & Gridina, 2000). Contrary to popular beliefs, media hype, and some previous research, HomeNetToo children made scant use of the Internet's communication tools. E-mail, instant messaging, and chat room conversations were infrequent activities at the start of the project, and the number of children participating in these activities dropped dramatically by the end of the project. Indeed, after 16 months of home Internet access, only 16% of the children were sending e-mail or participating in chat, and only 25% were instant messaging.

Why did HomeNetToo children make so little use of the Internet's communication tools? One explanation is so obvious as to be easily overlooked. HomeNetToo children were poor. In all likelihood, their friends and extended family members were poor. Poor people do not typically have home Internet access (Pew Internet & American Life Project, 2001a; U.S. Department of Commerce, 1995, 1997, 1999, 2000, 2002). Moreover, other evidence obtained from parents indicates that children were often forbidden from participating in chat or other activities that involved contact with strangers online (Jackson et al., 2004). Thus, with no friends and family to e-mail, and with chat activities and conversations with strangers explicitly forbidden, the fact that HomeNetToo children made so little use of the Internet's communication tools is not at all surprising (cf., Gross, 2004).

Another explanation for children's infrequent use of the Internet's communication tools lies in cultural influences on communication preferences. The majority of the children in the HomeNetToo project were African American (83%). African-American culture is historically an "oral culture" (Hale, 1982). For example, recent evidence indicates that African Americans prefer face-to-face communication to a far greater extent than do European Americans (Helms & Parham, 1990). The impersonal nature of the Internet's typical communication tools (e.g., e-mail) may have discouraged African-American children from using them. Perhaps as communication on the Internet becomes more enriched with

oral and visual cues, Internet use may become more appealing to members of other cultures.

Children's sociodemographic characteristics were related to their Internet use. As in previous research, older children used the Internet more than did younger children (Pew Internet & American Life Project, 2002; Turow & Nir, 2000). No evidence has been found that age influences whether the Internet was used for information or communication purposes or that age influences the benefits of Internet use to academic performance. However, unequal distribution of participants across the age range (10 to 18 years) may have obscured the finding of significant age effects (71% of participants were between 12 and 14 years of age). Nevertheless, our evidence that home Internet use benefits the academic performance of children as young as age 10 suggests that early home access for all children may be critical to leveling the educational playing field.

Extending previous research with adolescents and adults (Hoffman & Novak, 1998; Jackson et al., 2001a; Kraut et al., 1996; Pew Internet & American Life Project, 2000b; U. S. Department of Commerce, Internet Reports, 1995, 1997, 1999, 2000, 2002), European-American children in our research used the Internet more than did African-American children. As with age, these findings have implications for educational policy aimed at leveling the educational playing field. Although home Internet use may account for only a small portion of the variance in academic performance, race differences in home Internet use may serve to exacerbate existing race differences in academic performance.

The persistence of race differences in Internet use when access to the technology is not an issue suggests that cultural factors may be contributing to the racial digital divide (NSF Report, 2001). Perhaps the culture of the Internet, created primarily by European-American men, is not a welcoming culture for African-American children. Perhaps the design of Web pages, again primarily by European-American men, lacks esthetic appeal for African-American children.

Systematic research is needed to examine whether cultural characteristics and technology design interact to influence technology use and enjoyment. For example, if a preference for oral communication is responsible for race differences in Internet use observed in the HomeNetToo project and other studies (e.g., Hoffman & Novak, 1998), then changes in interface design that accommodate this preference may help reduce or eliminate race difference in use. As Internet technology evolves to support more multimodal, multisensory experiences, it may be better able to accommodate cultural influences on communication and other preferences.

## References

- Atwell, P. (2000). *Beyond the digital divide* [Working paper No. 164]. New York: Russell Sage Foundation.
- Blanton, W. E., Moorman, G. B., Hayes, B. A., & Warner, M. L. (1997). Effects of participation in the Fifth Dimension on Far Transfer. *Journal of Educational Computing Research*, 16, 371–396.
- Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge, MA: Harvard University Press.
- Gross, E. F. (2004). Adolescent Internet use: What we expect, what teens report. *Journal of Applied Developmental Psychology*, 25, 633–649.
- Hale, J. E. (1982). *Black children: their roots, culture, and learning styles*. Provo, UT: Brigham Young University Press.
- Helms, J. E., & Parham, T. A. (1990). The relationship between black racial

- identity attitudes and cognitive styles. In J. E. Helms (Ed.) *Black and White racial identity* (pp. 119–131). Westport, CT: Greenwood Press.
- Hoffman, D. L., & Novak, T. P. (1998). Bridging the racial divide on the Internet. *Science*, 280, 390–391.
- Jackson, L. A., Ervin, K. S., Gardner, P. D., & Schmitt, N. (2001a). The racial digital divide: Motivational, affective, and cognitive correlates of Internet use. *Journal of Applied Social Psychology*, 31, 2019–2046.
- Jackson, L. A., Ervin, K. S., Gardner, P. D., & Schmitt, N. (2001b). Gender and the Internet: Women communicating and men searching. *Sex Roles*, 44, 363–380.
- Jackson, L. A., Eye, A. von, Barbatsis, G., Biocca, F., Fitzgerald, H. E., & Zhao, Y. (2004). The social impact of Internet use on the other side of the digital divide. *Communications of the Association for Computing Machinery*, 47(7), 43–47.
- Kids Count Snapshot. (2002). Connecting kids to technology: Challenges and opportunities. The Annie E. Casey Foundation. Retrieved January 22, 2003, from [http://www.aecf.org/publications/pdfs/snapshot\\_june2002.pdf](http://www.aecf.org/publications/pdfs/snapshot_june2002.pdf)
- Kraut, R., Scherlis, W., Mukhopadhyay, T., Manning, J., & Kiesler, S. (1996). The HomeNetToo field trial of residential Internet services. *Communications of the Association for Computing Machinery*, 39, 55–65.
- Kulik, J. A. (1994). Meta-analytic studies of findings on computer-based instruction. *Technology Assessment in Education and Training*. Hillsdale, NJ: Erlbaum.
- National Center for Educational Statistics. (2000, February). *Internet access in public schools and classrooms: 1994–99. Stats in brief*. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.
- National Science Foundation Report (NSF). (2001, February). *Division of Science Resources Studies, The application and implications of information technologies in the home: Where are the data and what do they say*, NSF 01–313, Project Director, Eileen L. Collins, NSF/SRS: Author, Maria C. Papadakis, VA Polytechnic Institute and State University; and the Science and Policy Technology Program, SRI International (Arlington, VA).
- Norris, P. (2001). *Digital divide: Civic engagement, information poverty, and the Internet worldwide*. New York: Cambridge University Press.
- Pew Internet and American Life Project. (2000a). *Tracking online life: How women use the Internet to cultivate relationships with family and friends*. Retrieved January 24, 2001, from <http://www.pewinternet.org>
- Pew Internet and American Life Project. (2000b). *African Americans and the Internet*. Retrieved January 24, 2001, from <http://www.pewinternet.org>
- Pew Internet and American Life Project. (2002). *The digital disconnect: The widening gap between Internet savvy students and their schools*. Retrieved January 24, 2001, from <http://www.pewinternet.org>
- Project TELL (Telecommunications for Learning). (1990–1997). Stanton/Heiskell Center for Public Policy in Telecommunications and Information Systems, City University of New York Graduate School. Retrieved March 23, 2001, from <http://web.gc.cuny.edu/Shc/docu1.htm>
- Roberts, D. F., Foehr, U. G., Rideout, V. J., & Brodie, M. (1999). *Kids and media at the new millennium: A comprehensive national analysis of children's media use*. A Kaiser Family Foundation Report. Menlo Park, CA: Kaiser Foundation.
- Rocheleau, B. (1995). Computer use by school-age children: Trends, patterns and predictors. *Journal of Educational Computing Research*, 1, 1–17.
- Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordon, D. N., & Means, B. M. (2000). Changing how and what children learn in school with computer-based technologies. *Children and Computer Technology*, 10(2), Fall/Winter, 76–101. Retrieved September 3, 2001, from <http://www.futureofchildren.org>
- Shields, M. K., & Behrman, R. E. (2000). Children and computer technology: Analysis and recommendations. *The Future of Children*, Vol 10(2), Fall/Winter, 4–30. Retrieved September 10, 2001, from <http://www.futureofchildren.org>
- Stanger, J. D., Gridina, N. (1999). *Media in the home 1999: The fourth annual survey of parents and children (Survey Series No. 5)*. Norwood, NJ, Philadelphia: Annenberg Public Policy Center of the University of Pennsylvania. Retrieved October 3, 2000, from <http://www.appcpenn.org/pubs.htm>
- Subrahmanyam, K., Greenfield, P., Kraut, R., & Gross, E. (2001). The impact of computer use on children's and adolescents' development. *Applied Developmental Psychology*, 22, 7–30.
- Subrahmanyam, K., Kraut, R. E., Greenfield, P. M., & Gross, E. F. (2000). The impact of home computer use on children's activities and development. *The Future of Children*, 10, 123–144. Retrieved October 4, 2001, from <http://www.futureofchildren.org>
- Tapscott, D. (1998). *Growing up digital: The rise of the net generation*. New York: McGraw-Hill.
- Turow, J. (1999, May 4). *The Internet and the family: The view from the parents, the view from the press (Report No. 27)*. Philadelphia: Annenberg Public Policy Center of the University of Pennsylvania. Retrieved August 23, 2001, from <http://www.appcpenn.org>
- Turow, J., & Nir, L. (2000). *The Internet and the family 2000: The view from parents the view from kids*. Philadelphia: Annenberg Public Policy Center.
- U.S. Department of Commerce. (1995). *Falling through the Net: A survey of the "have nots" in rural and urban America*. National Telecommunications and Information Administration, U.S. Department of Commerce. Retrieved March 23, 2000, from <http://www.ntia.doc.gov/ntiahome/dn/index.html>
- U.S. Department of Commerce. (1997). *Falling through the Net: Defining the digital divide*. National Telecommunications and Information Administration, U.S. Department of Commerce. Retrieved March 24, 2000, from <http://www.ntia.doc.gov/ntiahome/dn/index.html>
- U.S. Department of Commerce. (1999). *Falling through the Net II: New data on the digital divide*. National Telecommunications and Information Administration, U.S. Department of Commerce. Retrieved March 23, 2000, from <http://www.ntia.doc.gov/ntiahome/dn/index.html>
- U.S. Department of Commerce. (2000). *Falling through the Net: Toward digital inclusion*. National Telecommunications and Information Administration, U.S. Department of Commerce. Retrieved January 27, 2001, from <http://www.ntia.doc.gov/ntiahome/dn/index.html>
- U.S. Department of Commerce. (2002). *A nation online: How Americans are expanding their use of the Internet*. National Telecommunications and Information Administration, U.S. Department of Commerce. Retrieved May 15, 2003, from <http://www.ntia.doc.gov/ntiahome/dn/index.html>
- UCLA Internet Project. (2000). *Surveying the digital future: Year 1*. UCLA Center for Communication Policy. University of California, Los Angeles. Retrieved June 22, 2001, from <http://www.ccp.ucla.edu>
- UCLA Internet Project. (2001). *Surveying the digital future: Year 2*. UCLA Center for Communication Policy. University of California, Los Angeles. Retrieved January 3, 2002, from <http://www.ccp.ucla.edu>
- UCLA Internet Project. (2003). *Surveying the digital future: Year 3*. UCLA Center for Communication Policy. University of California, Los Angeles. Retrieved February 4, 2004, from <http://www.ccp.ucla.edu>
- Valkenburg, P. M., & Soeters, K. E. (2001). Children's positive and negative experiences with the Internet: An exploratory survey. *Communication Research*, 28, 652–675.
- Wenglinsky, H. (1998). *Does it compute? The relationship between educational technology and student achievement in mathematics*. Princeton, NJ: Educational Testing Service.
- Woodward, E. H. IV, & Gridina, N. (2000). *Media in the home in 2000: The fifth annual survey of parents and children*. Philadelphia: Annenberg Public Policy Center, University of Pennsylvania.

Received August 2, 2004

Revision received November 28, 2005

Accepted December 12, 2005 ■