

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

Findings from the HomeNetToo Project

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Abstract

Research on the effects of home Internet use on children's academic performance is virtually nonexistent. Although parents believe that having the Internet at home is important to their children's success in school, evidence linking access to success is lacking. In the HomeNetToo project we automatically recorded the actual Internet use of 130 children (mean age=13) from low-income families for 16 months. Most of the children were African American (83%) and male (58%), and all resided in a mid-size urban community in the United States. Results indicated that Internet use predicted both grade point averages (GPAs) and standardized test scores. In general, the more frequently children used the Internet at home, the better their GPAs and standardized test scores. Implications for efforts to reduce the digital divide and facilitate access to technology for all children are discussed.

Categories and Subject Descriptors

K.4.0 [Computing Milieux]: Computers and Society; General

General Terms

Human Factors

Keywords

Children, academic performance and Internet use.

1. Introduction

Does using computers and other information and communication technology (ICT) influence children's cognitive outcomes, as reflected in academic performance, cognitive skills, and other measures of learning and

learning potential? The answer to this question is an unequivocal "maybe." Two recent (2000) reviews of the literature and a handful of studies since then offer encouragement, but no definitive conclusions about whether children's use of ICT contributes to favorable cognitive outcomes.

After reviewing 21 studies on school learning with computer-based technology, including 5 meta-analytic reviews, Roschelle and colleagues concluded that the findings are inconclusive [1]. For example, one meta-analytic review of over 500 studies (K-12 students) found that computer tutoring applications enhanced achievement test scores. However, other uses of the computer, such as simulations and enrichment applications, had only minimal effects [2]. Still other findings suggested that the benefits of computer-based instruction are clearer for math and science than for other subjects [3].

Subrahmanyam and colleagues [4] also reviewed the research on computer use and cognitive skills, focusing particularly on visual intelligence skills crucial to using computer technology (e.g., spatial skills, iconic and image representation skills). They concluded that computer use enhances a variety of cognitive skills. For example, children who play computer action games that involve rapid movement, imagery, and intense interaction show improved visual intelligence skills [5]. However, the authors caution 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, they point out that "...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 reviewed by Subrahmanyam and colleagues suggest relationships between digital technology use and academic performance, although causal relationships have yet to be established. Several studies have found that the presence of a home computer is a strong predictor of academic success, even after controlling for family income [5]. Findings from still other studies suggest that participating in a community of computer-based learners improves educational outcomes for at-risk children [6]. A more recent review by these same authors [7] upholds the conclusion that while preliminary evidence is encouraging [8][9][10][11], researchers have yet to establish a causal relationship between computer use and academic performance or between networked technology use (e.g., the Internet) and academic performance.

In summarizing the evidence relating technology use to cognitive outcomes, Shields and Behrman [12] concluded that the picture is sketchy and incomplete. Whether technology use improves performance on accepted measures of cognitive outcomes (school grades, standardized test scores) remains uncertain. Moreover, nearly all of the research has focused on stand-alone computer applications rather than on networked computers or Internet use.

The HomeNetToo project was designed to examine the cognitive, affective, and motivational antecedents and consequences of Internet use in low-income families www.HomeNetToo.org [13][14][15]. Among the cognitive consequences of Internet use considered in the project is children's academic performance, specifically, grade point averages (GPAs) and scores on standardized tests of achievement. Our optimistic prediction was that home Internet use would be positively associated with these outcomes: the more children used the Internet, the better their academic performance.

2. Methods

2.1 Participants

Participants were 143 children whose parents (N=117) agreed to participate in the project. Parents were recruited at meetings held at their children's middle school and at the Black Child and Family Institute, Lansing, MI. In exchange for allowing Internet use to be automatically recorded separately for all family members, and for completing surveys and participating in home visits at multiple points during the 16-month trial, participants were given new computers, home Internet access, and in-home technical support. Retention rate for the project 94%. Average age of child participants was 13.5 years old. Most of the children were African American (83%)

and male (58%). Approximate half the families had incomes of less than \$15,000 USD annually (49%).

2.2 Measures

Four server-logged measures of Internet use were obtained: time online (minutes/day), number of Internet sessions (log-ins/day), number of unique Web domains visited (per day), and number of e-mails sent (per day). For the analyses, Internet use was divided into 5 time periods to facilitate understanding of changes in Internet use and the antecedents and consequences of use over time: Time 1: 1 to 3 months, Time 2: 4 to 6 months, Time 3, 7 to 9 months, Time 4, 10 to 12 months, Time 5, 13 to 16 months. Because Internet use was highly variable and distributions were highly skewed, log transformations were used in all analyses.

Measures of Grade Point Average (GPA) and percentile ranks on the Michigan Educational Assessment Program (MEAP) tests of Reading and Mathematics (Comprehension Scores and Total Scores) were obtained directly from the local school districts (with parental permission). GPA measures were obtained for Fall 2000, before the project began, Spring 01, after 6 months of the project, Fall 01, after 1 year of the project, and Spring 02, the semester the project ended (April 02). MEAP scores were obtained for 2001, tests taken after 5 months of the project, and 2002, tests taken one month after the 16-month project ended.

Children completed surveys at pre-trial, one month, three months, nine months and post-trial. Each survey contained a variety of measures (e.g., social involvement, psychological well-being). Here we consider only the self-reported Internet logins and e-mail use. Specifically, children were asked: "How often do you logon to the Internet?" (1=Almost never, 2=2 or 3 times a month, 3=About once a week, 4=2 or 3 times a week, 5=Almost every day) and "How many e-mails do you send per week?" (1=None, 2=1 to 5 e-mails a week, 3=6 to 10 e-mails a week, 4=11 to 20 e-mails a week, 5=More than 20 e-mails a week.).

3. Results

3.1 Frequency of Internet use

Frequencies with which children used the Internet at home during each time period are presented in Table 1. Children spent an average of 27 minutes per day online, participating in 0.6 sessions and visiting 10 unique domains. They sent a negligible amount of e-mail - less than 1 e-mail per week. Paired contrasts to examine changes in Internet use over time (using log transformed

measures) indicated no changes in time online. However, number of sessions decreased between 6 months and 9 months, and remained at this level for the remainder of the trial (16 months). Number of domains visited increased between 3 months and 6 months, but decreased back to the initial level by 9 months, where it remained for the remainder of the trial. Number of e-mails sent was constant until the end of the first year, at which time it began to increase, reaching a peak by the end of the trial among those who continued using e-mail.

Table 1: Means levels of Internet use

	Time online (minutes)	# sessions (logins)	# domains visited	# e-mails sent
Time 1 (1 to 3 months)				
Mean	27	.75	9	.10
SD	38	.95	11	.57
Time 2 (4 to 6 months)				
Mean	30	.73	12	.10
SD	41	.99	16	.48
Time 3 (7 to 9 months)				
Mean	27	.60	10	.10
SD	41	.91	14	.63
Time 4 (10 to 12 months)				
Mean	27	.48	9	.10
SD	46	.71	11	.62
Time 5 (13 to 16 months)				
Mean	26	.45	9	.16
SD	48	.69	12	1.51

Note. Values are per day. SD=standard deviation.

Inspection of the frequency distributions indicated that a significant number of children never used the Internet at all, and an even greater number never used e-mail. Percentages of children who stayed away from the technology are presented in Table 2. As indicated in the table, the percentage of children who never logged on to the Internet increased from 9% to 16% during the trial. More dramatic were the percentages of children who never used e-mail. These increased from 59% at 3 months to 84% by the end of the trial (16 months).

Table 2: Children not using the Internet (%)

	Time 1	Time 2	Time 3	Time 4	Time 5
Logins	9	10	14	15	16
E-mail	59	61	70	72	84

Correlations between automatically logged Internet use and self-reported use were quite high, ranging from .41 to .66. Moreover, self-reported levels of use were consistent with actual use. For example, mean self-ratings of logins at post-trial was 3.68, where 3=about once a week and 4=2 or 3 times a week. Actually mean number of logins was 3. Mean ratings of number of e-mails sent was 1.99, where 1=none and 2=1 to 5 e-mails a week. Actual mean number of e-mails sent was 1 per week.

3.2 Race and Internet use

Mean levels of Internet use by African American and European American children are presented in Table 3. For every use measure except e-mail at time 1, African American children used the Internet less than did European American. Although they appear to use e-mail more throughout the trial, these differences were significant, attributable in part to the high variability and small number of children using e-mail. Thus, race differences in e-mail use remain uncertain.

Table 3: Race and Internet use

	Time 1	Time 2	Time 3	Time 4	Time 5	
	Af	26	28	37	32	28
Time online	Eu	49*	49*	58*	40*	44*
# sessions	Af	.78	.62	.56	.45	.40
	Eu	1.03*	1.09*	.99*	.70*	.76*
# domains	Af	9	11	11	9	9
	Eu	12*	18*	14*	12*	13*
# e-mails	Af	.14	.11	.13	.13	.19
	Eu	.04*	.07	.07	.02	.04

Note. Af=African Americans (N=120), Eu=European Americans (N=25). Values are per day. An * indicates a race difference significant at $p<.05$.

3.3 Race and Academic performance

Mean grade point averages (GPAs) and percentile ranks on the Michigan Educational Assessment Program (MEAP) tests for African American and European American children are presented in Table 4. African American children scored lower than did European American children on all academic performance measures except GPA, Spring 2001, for which the race difference was marginally significant ($p < .09$). Thus, we controlled for race in the analyses to predict GPA scores and MEAP percentile ranks from Internet use, presented next.

Table 4. Race and academic performance

		Mean	SD
Grade Point Average (0.0 to 4.0)			
Fall 2000*	Af	1.88	.95
	Eu	2.64	1.22
Spring 2001 ^H	Af	1.95	.89
	Eu	2.35	1.09
Fall 2001*	Af	1.95	.86
	Eu	2.55	.89
Spring 2002*	Af	1.92	1.04
	Eu	2.64	1.14
Michigan Educational Testing Program Tests: Percentiles			
Spring, 2001			
Reading	Af	27	24
Comprehension*	Eu	50	36
Reading	Af	27	25
Total Score*	Eu	51	35
Math	Af	27	22
Comprehension*	Eu	53	30
Math	Af	24	20
Total Score*	Eu	49	32
Spring, 2002			
Reading	Af	31	27
Comprehension*	Eu	50	35
Reading	Af	30	26
Total Score*	Eu	50	34
Math	Af	31	22
Comprehension*	Eu	46	26
Math	Af	26	22

Total Score*	Eu	46	31
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Note. Af=African Americans (N=120), Eu=European American (N=25). SD=standard deviation. An * indicates a race difference significant at $p < .05$. A ^H indicates a race difference significant at $p < .10$.

3.4 Predicting academic performance from Internet use

Because race predicted academic performance and Internet use, we controlled for race in the analyses to predict academic performance from Internet use. Internet use measures most proximate (in time) to assessment of that academic performance measure were used in the analyses. Thus, to predict GPA in Spring, 2001, we used a combined measure of Internet use at time 1 and time 2 (i.e., mean Internet use during the first 6 months of the project, ending June 30, 2001). To predict GPA in Fall, 2001, we used a combined measure of Internet use at time 3 and time 4 (i.e., mean Internet use during the second 6 months of the project, ending December 31, 2001). To predict GPA in Spring, 2002, we used measures of Internet use at time 5 (i.e., from January 1, 2002, until the end of the project, April 30, 2002). E-mail use was excluded from these analyses because rendered sample sizes too small for reliability (i.e., sample sizes were reduced by both the number of children not using e-mail, especially during time 5, and by incomplete academic performance data provided by the school district, due primarily to children not taking tests, moving to other school districts, or having incomplete records for some other reason.

To predict MEAP scores in Spring, 2001 we used a combined measure of Internet use at time 1 and time 2 (i.e., mean Internet use during the first 6 months of the project, ending June 30, 2001). To predict MEAP scores in Spring, 2002 we used measures of Internet use at time 5 (i.e., from January 1, 2002 until the end of the project, April 30, 2002). Once again, e-mail use was excluded from these analyses.

Table 5 summarizes results of the regression analyses to predict grade point average (GPA) from Internet use. None of the Internet use measures predicted GPA at the end of the first six months of the project. However, GPA at the end of one year of the project was predicted by the number of Internet sessions; the more sessions the child engaged in, the higher his or her GPA, even after controlling for the effects of race on GPA. At the end of project, number of sessions continued to predict GPA; more sessions during the last four months of the project (January 1, 2002 to April 30, 2002) were marginally

associated with higher GPAs at the end of that semester (June, 2002).

Table 5. Predicting academic performance

Predictor		F-ratio: Race	F-ratio: Change	R ²
GPA				
Spring 2001	Race, Internet use: T1+T2	2.83 p<.10 df=1,100	0.98 p<.46 df=3,97	.01
Fall 2001	Race, Internet use: T3+T4	7.05, p<.01 df=1,99	3.09, p<.05 df=3,96	.08
Spring 2002	Race, Internet use: T5	8.02, p<.01 df=1,79	2.88, p<.05 df=4,76	.09
MEAP Tests				
Spring 2001				
Reading Comprehension	Race, Internet use: T1+T2	11.60, p<.001 df=1,89	2.59, p<.05 df=3,86	.15
Reading Total Score	Race, Internet use: T1+T2	13.54, p<.001 df=1,89	2.83, p<.05 df=3,86	.17
Math Comprehension	Race, Internet use: T1+T2	18.02, p<.001 df=1,74	1.25, p<.30 df=3,71	.19
Math Total Score	Race, Internet use: T1+T2	20.28, p<.001 df=1,85	1.83, p<.15 df=3,82	.21
Spring 2002				
Reading Comprehension	Race, Internet use: T5	3.23, p<.08 df=1,61	2.86, p<.05 df=3,58	.12
Reading Total Score	Race, Internet use:	3.79, p<.05 df=1,61	2.96, p<.05 df=3,58	.13

		T5		
Math Comprehension	Race, Internet use:	1.20, p<.28 df=1,40	0.65, p<.59 df=3,37	.02
		T5		
Math Total Score	Race, Internet use:	6.84, p<.01 df=1,60	1.83, p<.15 df=3,57	.12
		T5		

Note: GPA=Grade Point Average. MEAP=Michigan Educational Assessment Program. Df=degrees of freedom. T=Time. R² is adjusted. In all the analyses race was entered in step 1 followed by three measures of Internet use in Step 2 (i.e., time online, # of sessions, # of domains visited).

Percentile ranks on the Michigan Educational Assessment Program (MEAP) tests were predictable from measures of Internet use (Table 7). Reading Comprehension and Total Readings scores obtained near the end of the first six months of the project (i.e., Spring, 2001) were predicted from time online during that time period (January 1, 2001 to June 30, 2001). Similarly, Reading Comprehension and Total Reading scores obtained during the spring that the project ended (i.e., Spring, 2002) were predicted from time online during that semester (i.e., January 1, 2002 to April 30, 2002). In both instances, more time online was associated with higher MEAP scores. However, math scores, either Comprehension or Total scores, could not be predicted from Internet use in either year.

To determine whether academic performance predicted Internet use (rather than the reverse, as in the previous analyses (see Table 5)), children's GPAs before the project were used to predict Internet use at Time 1 (i.e., first three months of the project). GPA did not predict subsequent Internet use, regardless of the measure of use, and regardless of whether or not race was controlled in the analyses. Similarly, GPA for Spring, 2001 did not predict Internet use during the subsequent time period (i.e., Time 3, July 1, 2001 to September 30, 2001), nor did GPA for Fall, 2001 predict Internet use during the subsequent time period (i.e., Time 5, January 1, 2002 to April 30, 2002).

To examine whether standardized test scores predicted Internet use (rather than the reverse, as in the previous analyses (Table 5)), test scores obtained Spring, 2001, were used to predict Internet use during the subsequent time period (i.e., Time 3). Regardless of the measure of Internet use (e.g., time online, # of session), test scores did not predict use.

4. Discussion

Findings from the HomeNetToo project support the following conclusions about home Internet use by low-income children in the United States. First, children make considerable use of the Internet at home, spending about 27 minutes per day on line. They log on less than once a day (i.e., they do not log on daily) and visit about 10 unique domains. The frequency of Internet use is relatively stable over time (i.e., the 16 months of the project), and appears to become more efficient as fewer log-ins are required to visit more domains in the same amount of time.

Second, self-reported Internet use is highly correlated with automatically recorded levels of use. Children in the HomeNetToo project were quite accurate in reporting how frequently they logged on to the Internet and how many e-mail messages they sent. Although we did not request estimates of time online, it seems likely that their estimates would be reasonable accurate for this measure as well. Such findings bode well for research that relies on self-report measures of Internet use, which constituted the overwhelming majority of research in this area.

Third, children in the HomeNetToo project make scant use of e-mail. In fact, e-mail use dropped from an initial low of 41% to a mere 16% of the children using e-mail by the end of the project. There are a number of explanations for the surprising lack of e-mail activity. First, it may be that children in the project, whose average age was 13 years old, used other Internet communication tools rather than e-mail to communicate with their friends. However, we recorded the number of IMC chat messages sent, as well as the number of chat rooms visited and the amount of time spent in chats. All of these activities were negligible, occurring even less frequently than e-mail use.

Another explanation for the lack of e-mail activity is that children were using another e-mail account to avoid being monitored by the project. Although we cannot rule out this explanation entirely, numerous home visits and interactions with participants, both children and their parents, indicated that participants were highly motivated to abide by the rules of the project, especially since violating these rules meant forfeiting their computers.

Yet another explanation for the lack of e-mail use by HomeNetToo children is that they simply had no one to e-mail. Because our participants were poor it is likely that their families and friends were also poor. Poor people, even in the U.S., do not typically have home computers and Internet access.

A fourth conclusion from our research is that race differences in Internet use persist, even when access to the technology is not an issue [16]. African American children used the Internet less than did European American children, regardless of which measure of

Internet use or time period was considered. Moreover, race differences in Internet use could not be attributed to race differences in GPAs or standardized test scores, neither of which predicted Internet use. Although findings for e-mail suggested that the African American children may use e-mail more than do European American children, at least initially, small sample sizes for these analyses caution against drawing any conclusions.

Fifth, and perhaps most important, Internet use predicts academic performance. Greater Internet use was associated with higher subsequent GPAs, and with better performance on standardized tests of reading skills (but not mathematics skills) administered after the Internet use period. The reverse was not true, that is, neither GPA nor standardized test scores predicted subsequent Internet use at any time during the 16 months of the project.

Our findings encourage continued efforts to reduce the divide that separates low-income children from those who already have Internet access. Not only do low-income children use the Internet, but they apparently use it in a way that contributes to their academic performance. Of course more research is needed to replicate these findings, determine their generalizability to other groups, and identify the mechanisms whereby Internet use might contribute to cognitive development. But these preliminary findings of the HomeNetToo project suggest that reducing the digital divide may help to reduce other divides that have defied countless previous efforts to reduce them.

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