The Impact of Technology Use on Low-Income and Minority Students' Academic Achievements: Educational Longitudinal Study of 2002

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Abstract

Analyzing data from the Education Longitudinal Study of 2002 (ELS:2002), this report examines how computer use produced generic benefit to all children and differential benefits to minority and poor children. Specifically, we examined computer use at home vis-à-vis computer use at school in relation to the academic performance of disadvantaged children and their peers. Home computer use typifies socially differentiated opportunities, whereas school computer use promises generic benefits for all children.

The findings suggest that, with other relevant conditions constant: (a) disadvantaged children did not lag far behind their peers in computer use at school, but they were much less likely to use computers at home; (b) computer use at home was far more significant than computer use at school in relation to high academic performance; (c) using a computer at school seemed to have dubious effects on learning; (d) disadvantaged children benefited less than other children from computer use, including computer use at home; and (e) compared to their peers, disadvantaged children's academic performance seemed less predictable by computer use than other predictor variables.

Introduction

It is overly simplistic to assume that new technologies applied to education will uniformly benefit all children in academic achievement. In this paper, we examine the relationship between computer use and academic achievement of students of different backgrounds. We propose generic benefits versus differential benefits of technologies as a conceptual tool to understand the relationship between computer use and student learning. Assessing how computer use at home vis-à-vis computer use at school provide generic and differential effects on student achievement, we analyzed data from the Education Longitudinal Study of 2002 (ELS:2002). We offer brief implications for improving curricula and instruction in technology-related programs to ensure equitable education.

Background: Social Stratification of Technologies

Dramatic technological advances promise to help educators realize the ideal of equal educational opportunity. Many believe that with powerful and cost-effective technologies, minority and poor children will be able to receive education of the same quality as their more fortunate peers (Gladieux & Swail, 1999; Panel on Educational Technology, 1997). New computing and network technologies can provide disadvantaged students with access to knowledge-building and communication tools and more individualized learning opportunities.

However, access to technology is not equitable across sociodemographic categories since it is determined by resources available to the schools, communities, and households. New technologies seem to best accommodate those who already take advantage of available educational opportunities (Barley, 1997). It is possible that use of these technologies may widen the educational gap in such a way that "advantage magnifies advantage" (Gladieux & Swail, 1999) as the advantaged benefit most from cutting-edge technologies whereas the most needy benefit least. Skeptics question whether new technologies per se, are able to improve educational equity since both access to and use of technologies are socially stratified.

There are clear patterns of uneven distribution of access to technologies, including computer and webTV ownership, Internet access, and email use (U.S. Department of Commerce, 1999). To date, the digital divide issue has turned on the concept of access (Ba, et al, 2001). Access has become an issue of social equity. Equal access to the technology and the skills to use it are increasingly necessary for economic success (Pachon, et al, 2000). Pearson (2002) indicated that there are large disparities between the access opportunities of the rich vs. poor and ethnic majority vs. ethnic minority populations. Concerning access to new technologies, poor and minority students are at a disadvantage.

The rates of the Internet access among individuals with high income and higher education are greater than the rates among those with low income and less education. Race-ethnicity was an important stratification factor in the rate of Internet access. Blacks and Hispanics are less likely to have Internet access at home than Whites and Asian Pacific Islanders, although the gap is narrower for Internet access outside the home. (U.S. Department of Commerce, 1999). Uneven availability and access exist among public schools with different socioeconomic student populations. In multiple measures of access, schools with a large number of poor students, receiving free or reduced price lunch, rated lower than to schools with smaller numbers of poor students (National Center for Education Statistics [NCES], 1999b).

Computers have been increasingly regarded as learning tools in education, but not a panacea for educational concerns (Pachon, 2000). However, students who do not have access to high-quality computer experiences at home or school are not being provided with the opportunities they need to be successful in society (Pearson, 2002). Lack of proper education is an important barrier to technology access and adoption (Hoffman & Novak, 1999).

The process of using technologies is socially differentiated as well. There are substantial differences between affluent and poor schools in the processes used by teachers in instructing their students on computer and Internet use. Teachers and students in poor schools are more likely to use the computer for drill practice and less likely to use it for research work when compared with their counterparts in affluent schools (NCES, 2000a). Disadvantaged students often attend unchallenging computer-related courses. They are more likely to take computer literacy classes than to use computers in the study of key subject areas. High-socioeconomic status (SES) students are more likely than low-SES students to engage in computer programming as opposed to lower-level computer-related tasks) and to use computers primarily for “higher-order” or “mixed” activities (rather than drill-and-practice activities). For challenging computer activities, High-SES students disproportionately receive better learning opportunities than poor and minority students (Wenlingsky, 1998). School reform involving new technological applications does not seem to narrow the divide, as revealed in a contrast between an impoverished public school and an elite private school (Warschauer, 2000). Students attending different schools are systematically channeled into distinctive futures via the *process* of assignment to technology-based programs: for the affluent, academic and research-oriented higher education; for the poor, workplace-oriented vocational learning.

Significantly, access to technologies at home has a great deal to do with *how* technologies are learned in school. Students whose families provide ready access to a computer are likely to take advanced computer classes at school involving such tasks as the analysis of complex systems and college-oriented academic work. In contrast, students who have no experience with computer at home often are placed in computer courses emphasizing routine skill learning or workplace-oriented training (e.g., Gladieux & Swail, 1999; Wenglinsky, 1998).

Concepts and Research Issues

We used a dual construct to examine computer use and academic performance, namely, *technically generic benefits versus socially differentiated benefits.* The former refers to the possibility that application of technology consistently benefits every student. Socially differential benefits, in contrast, hypothesize that the effects of technology vary by the social grouping of its users and by the social settings of its use.

Under the rubric of generic benefits, educational applications of technologies such as online instruction and interactive systems allow all learners to readily access vast amounts of information and to learn in an individualized process that accommodates their unique needs, abilities, and learning styles, thus helping to reduce learning gaps related to students’ social backgrounds (Panel on Educational Technology, 1997).

The perspective of socially differentiated benefits argues that disadvantaged children do not benefit from technologies as much as other children (Wenglinsky, 1998). Disadvantaged children, even with access to new technologies, are more likely to use them for rote learning activities rather than for intellectually demanding inquiries. The social conditions in which educational technologies are implemented and used may influence the technologies’ ability to narrow or widen historical disparities. Research has found that the traditional patterns of classroom organization might be impermeable to change, even with the wide availability of computers at school (e.g., Warschauer, 2000).

With the perspective of social stratification, the extent to which educational technologies improve student learning varies, partly depending on students’ socio-demographic backgrounds. From this perspective, home access to cutting-edge technologies is a key indicator of learning opportunity. Research has found that children with access to computers and the Internet at home are more confident and resourceful in using computer-related technologies at school. Lack of access at home, even when access is provided at school, handicaps many poor and minority children in productively using computers. Home access to a computer and the Internet, differentiated by SES, may be a significant source of educational inequality in the United States (Gladieux & Swail, 1999).

Further, we argue that computer use at home may help shape fundamentally different attitudes about using technologies for learning. Children from families with adequate material and cultural resources tend to "grow up with" cutting-edge technologies. They often are interested in new technological developments and intimately relate themselves to these changes by developing some sort of self-identity with technological products. Constantly curious about evolving high tech areas, these children are able to actively take advantage of new technologies for the study of core academic subjects as well as for entertainment.

In contrast, children from deprived home environments are not only unfamiliar with the novel ways of learning with new technologies, but also could be alienated from the rapidly-changing technologies that they have to deal with outside of home, including those found in the classroom. Without a technology-friendly home environment to foster their confidence and interest in computer-based learning, their attitude toward technologies could be indifferent or even hostile. In this study, we see that the use of computers at home typifies the socially differentiated benefit of technologies because it is largely determined by family material and cultural resources. School-provided access to computer-based learning, on the other hand, is presumably a remedy to the social stratification of technologies. It is expected to provide generic benefits of technology to all children since public schooling by default promises equitable education. Examining computer use at home and at school is thus the focus of this study.

Academic achievement is also conditioned by many other factors. School resources, instruction and curriculum, teacher expectation, and individual students' motivation to learn, are widely documented factors that influence academic performance. To isolate technologies' generic versus differential effects, we analyzed these factors together with computer use at home and at school in accounting for student academic performance.

Specifically, we attempt to address the following issues:

1. To what extent did disadvantaged students lag behind other students in computer use at school and computer use at home?

2. *Ceteris paribus,* how did computer use at home and school relate to high school students' academic achievement (generic benefits)?

3. Does the relationship between computer use and academic achievement differ across racial-ethnic and SES subgroups (differential benefits)? and

4. Did computer use help narrow achievement gaps associated with income and race-ethnicity among the NELS cohort? (gap-reduction effect)?

Methods

Data Source

The Education Longitudinal Study of 2002 (ELS:2002) will provide trend data about critical transitions experienced by 2002 base year 10^{th} grade students as they proceed through high school and into postsecondary education or their careers. Base year ELS:2002 was carried out in the spring term of the 2001–02 school year with a national probability sample of 752 public, Catholic, and other private schools. Data collection methods consisted of five separate questionnaires (student, parent, teacher, school administrator, and library media center), two achievement tests (assessments in reading and mathematics), and a school observation form (facilities checklist). Base year questionnaires were completed by 15,362 of the 17,591 selected sophomores, 13,488 parents, 7,135 teachers, 743 principals, and 718 librarians. The multilevel focus of ELS:2002 provides researchers with a comprehensive perspective of influences on the student including home, school, and the community. This perspective is essentially unified, the basic unit of analysis is the student.

Multiple regression analysis was used to examine each independent variable's relationship with academic performance, controlling for the other variables. A series of initial tests were run to explore alternative equations that could yield reasonably good fit with the data. In the final analysis, a series of equations were specified to assess the racial-ethnic and SES gaps in achievement in connection to computer access and other variables.

Variables

A description of each variable follows. The extracted data were edited and/or re-scaled. *Student academic performance* represented by the composite math/reading standardized test score at 10^{th} grade was used as the outcome indicator in this study. The composite score is the average of the math and reading standardized scores, re-standardized to a national mean of 50.0 and standard deviation of 10.0.The standardized T score provides a norm-referenced measurement of achievement relative to the population, Spring 2002 10th graders, as a whole. *Race-ethnicity* was a seven-category variable for (a) American Indian/Alaska Native, non-Hispanic, (b) Asian, Hawaii/Pacific Islander (API), non-Hispanic, (c) Black or African American, non-Hispanic, (d) Hispanic, no race specified, (e) Hispanic, race specified, (f) Multiracial, non-Hispanic, and (g) White. In multiple regression analysis, the grouping was dichotomous, one for American Indian/Alaska Native, Black or African American, Hispanic, and Multiracial, and the other for White and API. Combining White and API into a group was based on the established fact that the API group on average has similar computer access and academic performance as whites (see, for example, U.S. Department of Commerce, 1999; NCES 1999b; Jencks & Phillips, 1998). *SES* was indicated by a composite score derived from parents' educational attainment, parents' occupation, and household income. A derived quartile variable was used to define low-income students as those who were in the lowest quartile of the derived SES.

Computer use was represented by a series of variables, including student self-reported home computer use, school computer use, frequency of computer use at home and school, different modes of computer use, computer use in English and math courses, and computer use by English and math teachers for instruction. To examine the potential generic and differential benefits of technology access in connection to academic achievement, we attempted to sort out complex relationships between a group of relevant explanatory factors and academic performance which follow.

School factors included school socioeconomic composition, school geographic locale (urban, suburban, and rural), and school provision of computer-related programs and facilities. *Instruction/curriculum and teacher's expectation* indicated by students' placement of advanced placement program (versus general and vocational programs). English and math teachers' expectation for students' future education was viewed as another condition leading to meaningful use of technology in academic growth. *Family resource and support* indicated by SES, availability of a home computer, and parent's expectation for the child's education.

Analysis

Variables were analyzed through two-sample "t" test statistical procedures and multiple regression procedures. In the bivariate analysis, a large number of variables conceptually relevant to academic achievement and computer access were examined. Based on descriptive and bivariate analysis multiple regression analysis was conducted to examine the predictor variables' unique and joint relationships with academic performance. A series of initial tests were run to explore alternative equations that could yield reasonably good fit with the data. Particular attention was paid to testing of two-way interaction effects in order to detect joint effects of predictors on achievement. The tests include interactions between computer use/access and race-ethnicity, SES, curriculum and coursework, teacher educational expectations, and parent student educational expectations.

In the final analysis, a series of equations were specified to assess the racial-ethnic and SES gaps in computer access and the possible generic and differential benefits of computer use on academic performance. The first equation simply demonstrates the existing racial-ethnic and SES gaps in computer access. Subsequently, school, program, family, and psychobehavioral variables are entered into the equations to estimate how the two gaps might change. SPSS v12.0 was used to conduct descriptive procedures and AM v.0.06, provided by the American Institutes of Research and Jon Cohen and recommended by NCES for use with ELS:2002 data, was used to conduct multiple regression procedures.

Results

Research Issue 1: Computer Access and Use

Differences in computer use at home are evident both in race/ethnicity and SES subgroups (see Table 1). With regard to race, APIs (41.58%) and Whites (40.49%) frequency of computer use a home was well above the frequency of use for minorities, specifically Blacks/African Americans (28.40%) and Hispanics (26.98%). As one might expect, the low SES subgroup revealed less frequency of computer use when compared to higher SES subgroups. However, as we alluded to earlier, frequency of computer use at school was relatively similar across all race/ethnicity and SES subgroups. Frequency of computer use for school work revealed differences in the race/ethnicity subgroups, again between the non-API minorities using computers less and Whites/APIs with a higher percentage of computers use. The low SES subgroup revealed less computer use for school work than higher SES subgroups. Only minor differences in use of computers by students to learn on their own were evident in race/ethnicity and SES subgroups.

Table 1 *Computer Access/Use Gaps: Percentage of Computer Access/Use by Race-Ethnicity and Low-Income Status Subgroups of Base Year 2002 Sophomores*

Subgroup	How often uses computer at home[a]	How often uses computer at school[b]	How often uses computer for school work[c]	How often uses computer to learn on own[d]
Amer. Indian/Alaska Native	30.17%	19.52%	19.89%	18.65%
Asian, Hawaii/Pac. Islander	41.58	15.37	30.94	25.58
Black or African American	28.40	17.32	21.21	22.14
Hispanic, no race specified	29.71	15.21	21.11	20.31
Hispanic, race specified	26.98	14.61	21.08	19.34
Multiracial, non-Hispanic	34.29	16.94	22.80	21.05
White	40.49	16.62	24.97	21.07
Other SES	39.74	16.28	25.03	21.04
Low SES	26.71	16.93	17.98	17.16

Note. Values enclosed in parentheses represent standard errors. From U.S. Department of Education, National Center for Educational Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base Year" panel data. [a]Based on BYS47A, a scale ranging from 1 through 5 indicating increasing frequency of computer use, where use was defined as a 4 and 5 rating average. [b]Based on BYS47A. [c]Based on BYS47A. [d]Based on BYS47A.

Research Issue 2: The Generic Benefits of Computer Use

We examined the generic benefit of computer use at home and at school with different variables in relation to the math and reading composite score, upon controlling for the effects of variables that have been documented as relevant to achievement (*ceteris paribus* for correlation statements thereafter). In Table 2, with the first equation, we estimated the achievement gaps associated with SES and race-ethnicity. SES is a strong positive predictor of the achievement (with beta= 4.94, and $p<0.01$). We separately estimated the racial differences with six binary variables, each representing a contrast between a given minority group and Whites. The API and Multiracial groups had a higher average score than the Whites (beta=-4.68 and -1.79 at $p<0.01$ respectively). Blacks/African Americans and Hispanics, race specified, showed significantly lower average achievement (2.31 and 0.91 respectively, at the $p<0.01$ level). The American Indian/Alaska Native and Hispanic, race not specified, revealed no significance.

We then recoded the race-ethnicity into a single binary variable, which contrasted non-API minority groups with Whites and APIs. In equation 2, we entered a set of individual and school background variables that were presumably predictive of achievement, together with SES and the non-API minority dichotomy. This procedure allowed us to demonstrate that most background variables were related to achievement, as expected, and then to further test the effects of computer use/access measures after controlling for these background variables.

Note that the achievement gaps related to SES and race-ethnicity decreased as those individual and school variables entered into the equation. This implies that those predictor variables accounted for a large portion of the two gaps, meaning that providing the similar conditions on those variables, low-income and minority students would have done less poorly in math and reading tests relative to Whites and APIs.

To identify a generic benefit of computer use and access in raising the achievement level, we entered into equation 3 a group of nine variables measuring computer use and access. Of these variables, six estimates were statistically significant. Owning a home computer was found to be significantly related to high achievement (beta=1.05 at $p<0.01$). Three variables related to frequency of computer use at home, at school, and computer use for school work revealed significance (beta=0.62, 0.36, and 0.96 respectively, all at the $p<0.01$ level). While computer use in 9th grade fall and spring math did not produce significance, computer use in 9th grade fall and spring English revealed an interesting finding: both produced significance at the $p<0.01$ level, however, the effect was different for fall and spring (beta=-1.25 and 1.45 respectively).

Table 2 *SES and Racial-Ethnic Gaps in Math and Reading Composite Test Score and Generic Benefit of Access to and Using Computer: Multiple Linear Regression Coefficient Estimates*

Independent Variables	Equation 1: SES and race-ethnicity gaps	Equation 2: SES and racial-ethnic gaps net of backgrounds	Equation 3: Generic benefit of computer access/use

Socio-economic status composite, v.2	4.94 (0.14)**	4.80 (0.14)**	3.92 (0.17)**
Non-API minorities vs. White	-- --	5.34 (0.26)**	4.42 (0.30)**
Amer. Indian/Alaska Native, non-Hispanic vs White	0.68 (0.72)	-- --	-- --
Asian, Hawaii/Pac. Islander,non-Hispanic vs. White	-4.68 (0.39)**	-- --	-- --
Black or African American, non-Hispanic vs. White	2.31 (0.29)**	-- --	-- --
Hispanic, no race specified vs. White	0.28 (0.34)	-- --	-- --
Hispanic, race specified vs. White	0.91 (0.35)**	-- --	-- --
Multiracial, non-Hispanic vs. White	-1.79 (0.42)**	-- --	-- --
Advanced Placement Courses		4.36 (0.25)**	4.12 (0.27)**
School urbanicity		0.05 (0.21)	0.01 (0.22)
Grade 10 percent free lunch-categorical		-0.52 (0.34)	-0.44 (0.44)
Family has a computer			1.05 (0.51)*
How often uses computer at home			0.62 (0.13)**
How often uses computer at school			0.36 (0.12)**
How often uses computer for school work			0.96 (0.13)**
How often uses computer to learn on own			0.08 (0.10)
Used computer in 9th grade fall English			-1.25 (0.49)**
Used computer in 9th grade spring English			1.45 (0.39)**
Used computer in 9th grade fall math			-0.37 (0.48)
Used computer in 9th grade spring math			-0.55 (0.46)
Intercept	73.40	69.80	63.22
R^2	0.26**	0.29**	0.33**
Number of parameters	7	5	14
N of weighted cases [a]	15362	11639	8647

Note. Values enclosed in parentheses represent standard errors. From U.S. Department of Education, National Center for Educational Statistics, Education Longitudinal Study of 2002 (ELS:2002), “Base Year” panel data.
[a]The number of cases changed across equations due to list-wise deletion of missing cases.
* p<0.05. **p<0.01.

Research Issue 3: The Differential Benefits

Does computer use help some children but not others? Or does it help one group *more* than other groups? To examine the role of computer use in promoting academic performance of students of different SES and racial-ethnic backgrounds, we separated the analysis by the subgroups. Table 3 shows multiple regression coefficient estimates for comparison of non-Asian minorities against APIs and Whites and of the low-SES group, defined by the lowest quartile of the SES composite score, against the group of other SES quartiles. Between the two racial-ethnic groups, there were differences in effects of several predictor variables including advanced placement courses, and parents’ expectations for students’ college education.

One particular computer-relevant variable differed in relation to achievement across the both race and SES groups. Computer use for school work produced a positive effect on the API and White group (beta= 0.39 and p<0.01) whereas it did not make a difference among minority students. This variable also produced a positive effect on the Other SES quartile group (beta= 0.33 and p<0.01) whereas it did not make a difference among Low SES quartile students.

Table 3 *Examining Differential Benefit of Access to and Using Computer by Race-Ethnicity and SES: Multiple Linear Regression Estimates for Racial-Ethnic and SES Subgroups*

Independent variables	Non-API minority students	API and White students	Lowest SES quartile students	Other SES quartile students
Socio-economic status composite, v.2	2.83 (0.21)**	2.97 (0.18)**	----	-- --
Non-API minorities	-- --	----	4.84(0.40)**	5.72 (0.29)**
Grade 10 percent free lunch-categorical	-0.10 (0.05)*	-0.05 (0.04)	-0.05(0.05)	-0.11 (0.04)**
School urbanicity	0.45 (0.30)	0.10 (0.23)	0.19(0.28)	-0.01 (0.22)
Advanced Placement Courses	2.51 (0.40)**	3.50 (0.27)**	2.57(0.55)**	3.53 (0.26)**

How far teacher expects student to get in school (English)	0.21 (0.05)**	0.22 (0.04)**	0.24 (0.06)**	0.25 (0.04)**
How far teacher expects student to get in school (math)	0.21 (0.05)**	0.39 (0.04)**	0.29 (0.05)**	0.38 (0.04)**
How far in school student thinks will get-composite	0.62 (0.07)**	0.54 (0.05)**	0.52 (0.08)**	0.69 (0.05)**
How far in school parent wants 10th grader to go-composite	0.63 (0.11)**	1.39 (0.09)**	1.06 (0.11)**	1.33 (0.09)**
Family has a computer	0.27 (0.04)**	0.18 (0.04)**	0.28 (0.05)**	0.20 (0.04)**
How often uses computer at home	0.34 (0.07)**	0.26 (0.07)**	0.25 (0.08)**	0.40 (0.07)**
How often uses computer at school	0.01 (0.08)	0.04 (0.06)	0.01 (0.09)	-0.04 (0.06)
How often uses computer for school work	-0.09 (0.10)	0.39 (0.08)**	0.02 (0.11)	0.33 (0.09)**
How often uses computer to learn on own	0.09 (0.09)	-0.01 (0.07)	0.00 (0.10)	0.01 (0.07)
Mean Square Error	64.02	58.85	59.92	63.76
R^2	0.23**	0.33**	0.24**	0.32**
Number of parameters	13	13	13	13
N of weighted cases	4788	9689	2945	10146

Note. Values enclosed in parentheses represent standard errors. From U.S. Department of Education, National Center for Educational Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base Year" panel data.
* p<0.05. **p<0.01.

Research Issue 4: The Gap-Reduction Effect

How does computer use/access at home help narrow achievement gaps associated with income and race-ethnicity? With frequency of home computer we could distinguish the ELS:2002 respondents into three groups. A majority group (n=5,667) included the students who use computers at home ranging from once or twice a week to everyday or almost everyday (frequent), the second group (n=1,061) who use computers at home ranging from less than once a week to never (not frequent), and a third group (673) that did not have a computer at home (no computer)(see Table 4). Separately estimating the same regression equation for the three groups revealed considerable differences in academic achievement gaps relating to income, race-ethnicity, and other relevant variables. The advanced placement course variable produced a positive effect on the frequent home computer use group (beta=2.64 at p<.01) with no effect on the not frequent and no home computer groups. Variables related to college expectations including English and math teachers', parents', and student's, all produced a positive effect on students that own a home computer. Frequency of computer use at school revealed positive effects for the frequent and not frequent home computer use groups (beta 0.31 at p<0.01 and beta 0.70 at p<.05 respectively). The effect of the frequency of computer use to learn on own variable revealed a positive effect (beta 0.32 at p<0.01) for the frequent home computer use group and a negative effect (-0.61 at p<0.05) for the group with no home computer.

Table 4 *Gap-Reduction Effect: Multiple Linear Regression Coefficient Estimates in Equations for Students Who Used PC at Home and Students Who Did Not Have a PC*

Independent variables	Students that used PC at home once or twice a week to everyday or almost everyday		Students that used PC at home less than once a week to never		Students that did not have a PC at home	
Socio-economic status composite, v.2	1.41	(0.20)**	1.02	(0.40)*	0.39	(0.57)
Non-API minorities	3.85	(0.36)**	4.61	(0.60)**	4.03	(0.66)**
Grade 10 percent free lunch-categorical	-0.45	(0.08)**	-0.51	(0.18)**	-0.66	(0.20)**
School urbanicity	0.57	(0.22)**	0.44	(0.40)	0.23	(0.46)
Advanced Placement Courses	2.64	(0.26)**	0.94	(0.72)	0.09	(0.92)
How far teacher expects student to get in school (English)	1.71	(0.12)**	1.50	(0.24)**	1.56	(0.28)
How far teacher expects student to get in school (math)	2.02	(0.11)**	1.87	(0.23)**	2.00	(0.29)

How far in school student thinks will get-composite	0.11	(0.06)**	0.29	(0.13)*	0.14	(0.14)
How far in school parent wants 10th grader to go-composite	0.54	(0.10)**	0.67	(0.19)**	0.40	(0.23)
How often uses computer at school	0.31	(0.12)**	0.70	(0.29)*	0.63	(0.34)
How often uses computer for school work	-0.08	(0.15)	-0.15	(0.28)	0.01	(0.32)
How often uses computer to learn on own	0.32	(0.10)**	0.21	(0.26)	-0.61	(0.29)*
Mean Square Error	45.18		50.73		50.26	
R^2	0.50**		0.44**		0.38**	
Number of parameters	12		12		12	
N of weighted cases	5667		1061		673	

Note. Values enclosed in parentheses represent standard errors. From U.S. Department of Education, National Center for Educational Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base Year" panel data.
* $p<0.05$. ** $p<0.01$.

Discussion

Our analysis of the NELS data, adjusted for a series of individual and school background factors, generated the following findings: (a) disadvantaged children did not lag far behind their peers in computer use at school, but they were much less likely to use computers at home; (b) computer use at home was far more significant than computer use at school in relation to high academic performance; (c) using a computer at school seemed to have dubious effects on learning--taking computer science courses at school related consistently to low performance for both the disadvantaged and their peers; (d) disadvantaged children benefited less than other children from computer use, including computer use at home; and (e) compared to their peers, disadvantaged children's academic performance seemed less predictable by computer use than other predictor variables.

Income is a stronger indicator than race regarding the use of computers and students' achievement, and the strength of the evidence seems to be clear that socioeconomic factors appear to play a disturbing role in student access to computers. In many cases, there are demographic correlations between ethnicity and income level; however, affluence is the key factor in determining the positive influence of computer use on student performance. Focus should therefore be given not only to racial minorities but also to the SES minority in order to best implement technology for achievement.

Computer use at home was far more significant than computer use at school in relating to high academic performance, but this effect was absent for minority and low-SES children. These findings support the notion that seemingly ubiquitous computer-based technologies are nevertheless differentially available and functioning by social and demographic groups. Public education has not remedied the problems imposed by the social stratification of technologies. The findings refute the over-simplistic belief that application of technology could benefit all children in public schools by closing achievement gaps.

This analysis seems to underscore a need for reform of technology policies and computer-related curricula/instruction to provide equitable education for all children. The pattern that computer science classes in general were related to low achievement points to the possibility that ill-designed curriculum or poor instruction rendered such technology-oriented programs disappointing. Also, achievement-irrelevance of a number of variables of computer use-at school or setting-free-suggests that technologies per se may not work to help performance. Especially, technologies alone would not work well for closing achievement gaps as the performance of minority and poor children was related to computer use to only a limited extent.

These findings present clear evidence in terms of the relationship between socioeconomic factors, equitable distribution and use of computers, teacher technology training, and students' performance. In light of this, it is imperative that "equity" in school computer usage must involve not only equity in access but also equity in consideration of the learning needs of low-income and minority students. It follows, then, that teacher technology training is as important as socioeconomic factors in determining the level of SES achievement by the career graduate. Increased access to computers will only have positive results when the educator has a complete grasp of the role and use of computers, and an understanding of the student's home environment and how their deficiencies must be met in order to realize their full potential, thus enhancing society instead of reducing the average achievement.

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