What's School Got to Do With It?
Cautionary tales about correlations between student computer use and academic achievement

Jason Ravitz
John Mergendoller
Buck Institute for Education

Wayne Rush
J.A. & Kathryn Albertson Foundation

Ravitz, J., Mergendoller, J. & Rush, W. (2002, April). Cautionary tales about correlations between student computer use and academic achievement. Paper presented at annual meeting of the American Educational Research Association. New Orleans, LA.

ABSTRACT
This paper explores questions about whether there is a positive or negative relationship between student computer use and achievement, and whether results vary by the amount of school or home computer use. We find that generally there is an inverse relationship between *in-school* computer use and student achievement. However, there is a positive overall relationship between student achievement and computer *proficiency*, i.e., reported capability with a variety of software. Importantly, the student software capability is related to use both at school *and* at home. Because of the differing interpretations that are possible and the importance of the topic, caution is urged. Researchers and policy makers must think carefully when interpreting correlational results between achievement and student technology use measures, regardless of whether the direction of the proposed relationship is positive or negative.

PURPOSE
In today's climate of educational accountability, considerable attention is focused on students' academic achievement and the school environment necessary to develop and support achievement. An up-to-date technological infrastructure is generally considered a key part of an effective school environment. Special attention has been focused on the "digital divide" separating disadvantaged urban and rural students from more advantaged suburban students. Government funding has been focused on urban and rural schools in order to infuse technology in these schools and provide disadvantaged students with technological opportunities equal to those found in suburban schools. Such an approach assumes that it is computer use at school that is associated with academic achievement. Our analyses have led us to question, however, whether this is indeed the case.

The purpose of this paper is to explore the relationships between student computer use at school, computer use at home, and academic achievement. A few studies have indicated that there are achievement advantages for computer using students, particularly those who have access to home computing opportunities. For example, Green (1998) reported greater achievement gains in language arts, reading and mathematics among 8^{th} and 11^{th} grade students who were more competent and frequent computer users. Most studies, however, have not distinguished the separate relationship home and school computer use may have with academic achievement. An exception is Weglinsky (1998), who found that home computer use was positively related to academic achievement, while an emphasis on in-school use was negatively related to academic achievement. This last finding, in conjunction with other research (Becker & Ravitz, 1998; Becker, Ravitz & Wong, 1999) suggests that there may be a "pedagogical divide" at school where lower achieving students engage in more rudimentary computer uses devoted to drill and remediation.

This paper seeks to address the following research questions:

1) **Descriptives:** How do schools and students differ in technology use and achievement, and what are major variables that need to be controlled to identify an independent effect of technology?

2) **Computers and Achievement**: Are higher achieving students more proficient computer users? Is computer proficiency related to both raw achievement *and* achievement gains from year-to-year?

3) **School or Home:** Which location of use is more closely associated with computer proficiency, raw achievement scores, and achievement gains from year-to-year?

METHODS

This study uses individual and school wide and student-level measures of student achievement based on the Iowa Test of Basic Skills and the Test of Academic Proficiency (ITBS / TAP).

School Data Set. To address variations in technology presence and conditions at the school level we used the School Technology Inventory completed by school or district level administrators throughout the state. For a measure of school size we used the athletic categories used in Idaho for both 8th and 11th grade schools; these are based on the number of students in each school.

Student Data Set. We obtained data from the statewide administration of the Iowa Tests of Basic Skills in Language Arts, Reading, and Mathematics (ITBS). The total number of students in the study is 31,000 from over 300 schools. As part of the Idaho Statewide Testing Program, all 8th and 11th graders completed a 17 item self-report instrument describing their competency with educational computer use**,** their opportunities to use computers in school, and the frequency with which they used computers at school and at home.

- **Measuring Achievement:** The ITBS scores for Reading, Language and Math from both 1999 and 2000 were all highly correlated ($r > .72$). Achievement z-scores were assigned after splitting the file by student gender and grade (8th or 11th) because girls scored higher in language arts.

- **Measuring Achievement Gains.** Because scores generally rose between 1999 and 2000, we want to compare students' gains. In addition, because higher scoring students and lower scoring students may gain at different rates, we want a standardized way of comparing gain scores. The standardized residual gain score indicates the gain in test scores *relative to what would have been expected* based on knowledge of the first year test scores.

- **Student Self-Ascribed Computer Proficiencies and Use:** A subset of the 17 item instrument asked specifically about capabilities to perform tasks, such as word processing, spreadsheets, presentations, Internet and email. Students were asked to indicate (8, 4-7, 1-3, 0 hours) how much they used computers at school and at home. The index score had a reliability alpha of .75.

- **Statistical significance.** Due to the large sample sizes, even inconsequential differences are statistically significant at $p < .001$. Eta provides a better estimate of the differences in means between ordered groups of cases.

FINDINGS

To date we can report the following findings from our work:

Using percentage of student users as a measure, there is a *negative* relationship between use of computers by students at school and school wide achievement. This is because a greater percentage of students in smaller, lower performing schools, and a smaller percentage of students in larger, higher performing schools, use computers at school.

There are substantial differences in student technology use and achievement by school size and grade. Most of Idaho's *schools* are small and in rural areas, but more *students* attend the few larger, urban schools. The rural, small schools have more computers per student and a larger proportion of students using computers in school, compared to urban, larger schools. Almost 1/3 of home-only users are in the 5th (wealthiest) MFI89 quintile, while over ¼ of the school-only users are in the 1st (poorest) MFI89 quintile. It seems a few computers go a long way in small schools and not in large schools. While students in urban, large schools less often use computers at school, they more often use computers *at home*.

Larger 8th and 11th grade schools had higher ITAP/TAP test scores in 1999 and 2000. Larger 11th grade schools also gained more on the TAP from 1999 to 2000; however, for 8th grade schools, there is some evidence that it was the smaller schools that gained more on ITAP from 1999 to 2000 (Ravitz & Mergendoller, 2002).

Looking at Table 1, it is apparent that family income is related to school size. Patterns of computer use *at home* generally follow school size (and income) patterns. *Patterns of school achievement are positively related to home computer use and family income and inversely related to school computer use*. This relationship generally persists, even controlling for school size.

The same pattern is found when one compares school achievement and income, or school achievement and home computer use. Larger schools enroll higher achieving students at both the 8th and 11th grades, across all three subject areas (ibid). Note that this reflects test scores at one point in time (October 2000), and does not address the issue of whether there were differential achievement gains between 1999 and 2000 in larger or smaller schools.

Overall 2000 school achievement is reported on Table 1 using school-level standardized z-scores derived from an aggregate index combining 2000 mathematics, language arts, and reading scores for the students in each school. Standardized scores remove the effect of the mean and standard deviation, so the "average" score is 0.00 and the standard deviation is 1.00. Looking at schools containing the 8th grade and schools containing the 11th grade, we find a consistent pattern of the smallest schools exhibiting a negative z-score. The z-score then increases (e.g., achievement scores rise) in relationship to the size of the school.

Table 1. Location of Computer Use, Achievement, and Income Data, by School Grade and Size

Grade	School size (sports categories)	Average % of students who use computers at school	Average % of students who use computers at home	Average number of school computers per 10 students	Overall 2000 *school* achievement (standardized z-score) within grade	Median family income (1990) in thousands
8	< 150	74%	62%	4.1	-0.48	27.0
	150-349	79	73	3.0	0.03	25.6
	350-799	67	78	1.9	0.19	28.2
	800-1249	53	83	1.9	0.44	33.7
	All 8th grades	72	73	2.8	0.00	27.3
11	< 150	81	72	5.0	-0.79	27.3
	150-349	79	79	3.3	0.01	25.8
	350-799	73	80	2.2	0.35	26.6
	800-1249	61	84	2.2	0.55	30.0
	1250+	50	85	1.7	0.67	31.0
	All 11th grades	73	79	3.2	0.00	27.2
All	< 150	77	67	4.6	-0.64	27.2
	150-349	79	76	3.1	0.02	25.7
	350-799	70	79	2.0	0.25	27.5
	800-1249	58	83	2.1	0.51	31.3
	1250+	50	85	1.7	0.67	31.0
	All schools	73	76	3.0	0.00	27.2

Note: Standard deviation for PCs per 10 students = .22. Standard deviation of median family income, in thousands = 4.3.

It is evident that one must control for school size and/or income to understand accurately the relationship between technology use and student achievement. It may be the case that *home* computer use has a greater impact on student learning in Idaho's larger school districts, and *school* computer use is more important in smaller, rural schools.

Similarly, students who score better on standardized achievement tests are those who use computers more often at home, and less at school.

Replicating the above findings at the student level, students who score better on standardized achievement tests are those who use computers more often at home, and less at school. This suggests again that home use, not school use is associated with greater achievement (Table 2).

Table 2. Mean Achievement (ITBS) Z-Scores by Grade, Gender, and Computer Use Location: Higher achieving students use computers less at school and more at home.

		Computer Use at School per week				
Gender	GRADE	0 Hours	1 to 3 Hours	4 to 7 Hours	8 or More Hours	Total
Female	8	.04	-.05	.08	**-.23**	.00
Male	8	.04	-.01	.08	**-.28**	.00
Female	11	**.16**	-.08	-.07	**-.17**	.00
Male	11	.09	-.04	.01	-.04	.00
	Total	.08	-.04	.03	**-.19**	.00
		Computer Use at Home per week				
Female	8	**-.38**	.02	**.22**	.09	.00
Male	8	**-.37**	.00	.16	**.21**	.00
Female	11	**-.44**	.00	.15	**.32**	.00
Male	11	**-.42**	-.08	.15	**.35**	.00
	Total	**-.40**	-.01	.17	.24	.01

Note: Cells show mean z-score for row. Lowest Row or Column N > 4900, Lowest Cell n > 228.|

Male students in 8th grade who report using computers *at school* for 8 + hours per week score on average one-quarter standard deviation *lower* on standardized tests than do 8th grade boys as a whole (Table 2). This pattern also seen for 8th grade and 11th grade girls, but is not seen for 11th grade boys, a finding that will be pursued in future analyses.

At home, more use is associated with higher scores. The only exception is 8th grade girls; moderate use at home (4-7 hours/week) is reported by the higher scorers. This is because a greater proportion of students in large schools do not have access to computers at school, but they do have access at home.

Although we admit to having a very weak measure of SES (1989 mean family incomes for the school zip code) the relationships shown seem to operate *independently of SES*.

Importantly, it is not just in high income schools where home computer users score higher on tests and school computer users score lower. More extensive users at home score higher on standardized tests and more extensive users at school score lower on standardized tests, even when we split the file by SES quintiles (Table 3).

If the relationships between home use, school use, and test scores that have been shown were solely a result of SES, then we might expect the relationships to disappear when we control for SES by splitting the file. High SES students using computers at school would not exhibit lower scores; low SES using students using computers at home would not score higher than the group as a whole.

Although we cannot rule out the possibility that there are still student-level differences based on family income within these quintiles, the relationships reported above generally appear to hold true even when we control for the SES of the school.

Table 3. Achievement and proficiencies by amount of home and school use, by SES

MFI89 Quintiles	Hours of Computer Use Per Week	**Test Scores by Use at Home**	Proficiency scores by Use at Home	% Users at Home (within Quintile)	**Test Scores by Use at School**	Proficiency Scores by use at School	% Users at School (within Quintile)
1st Quintile	0	**-.49**	1.74	23	-.15	1.91	25
Low income	1 to 3	-.19	1.99	35	-.21	2.07	50
	4 to 7	-.01	2.21	24	-.09	2.19	19
	8 or More	**.10**	2.39	17	**-.24**	2.34	6
		(-0.17)	(2.07)	(100)	(-0.17)	(2.07)	(100)
5th Quintile	0	**-.26**	1.61	15	**.22**	1.95	48
High income	1 to 3	.13	1.96	40	.12	2.12	34
	4 to 7	.34	2.20	26	.16	2.24	13
	8 or More	**.34**	2.44	19	**-.12**	2.25	5
		(0.17)	(2.06)	(100)	(0.17)	(2.06)	(100)
Total	0	**-.40**	1.68	19	**.08**	1.93	35
	1 to 3	-.01	1.98	37	-.05	2.09	43
	4 to 7	.17	2.20	26	.03	2.19	16
	8 or More	**.24**	2.40	18	**-.20**	2.30	6
	Total	(.00)	(2.06)	(100)	(.00)	(2.06)	(100)

Note: Similar patterns appear for the other quintiles.

In summary, findings about how achievement varies according to school and home use are consistent; they occur somewhat independent of SES.

Analyzing Student Software Capability instead of Home vs. School Use

There is another conceptualization of technology use in schools that emphasizes how home use and school use might support each other to influence learning. One could argue that our question should not be whether the isolated school use contributes to achievement but whether a student's overall experience with technology does. One could argue that capability with technology is more important than location of use and that limiting studies to classroom use and removing the effect of home use, is counter productive to understanding the real influence of technology.

Besides conducting separate analyses of school and home use there are other ways to control for home and community effects. The first involves looking at within-school differences in proficiency and achievement, the second concerns looking at residual test score gains. We might decide to focus on student software *capability*, a measure that is related to student software use at home *and* at school. Doing so, we uncover findings that point to a *positive* relationship between technology proficiencies and student achievement.

Within schools, students who have higher software capability not only score higher on tests but they also *gained* more, on average, from 1999 to 2000

Comparing student level data and looking at individuals within schools (our best available control) – students who have higher software capability not only score higher on tests but they also *gained* more, on average, from 1999 to 2000. These findings are, of course, statistically significant, $p < .001$, effect size = .35 for 2000 achievement; effect size = .18 for year-to-year gains.

Students were characterized compared to others within their school as being either high or low in software capability; we then analyzed how their achievement scores differed from others within their school. Table 4 shows that student overall achievement within their school is related to their level of software capability. Students who are characterized as having high computer capability scored higher on the combined measure of mathematics, reading and language arts achievement than students who had lower computer capability within their schools.

Table 4. Student Within-School Achievement, by Software Capability

Students within their school characterized as having…	Mean z-score on 2000 tests	N	Effect Size
Low software capability	-.15	14650	
High software capability	.17	14657	.35
Total	.00	29307	

Note: The mean z-score on the 2000 tests are shown, not gains. Effect size is based on the standard deviation for the 2000 combined test score index, .91. The difference is statistically significant, $p < .001$.

The above table shows that students who report more software skills scored higher on the 2000 tests than others within their school. The effect size for students with higher software capability is .35, or about one-third a standard deviation. These scores place high software capability students, on average, at the 57th percentile and low software capability students at the 44th percentile, for students within their schools. The next table addresses whether students with high software capability also *gained* more than others within their school, controlling for their 1999 scores.

It is important to make a distinction between technology use as a predictor of overall "raw" achievement (relatively easy to show, tied to many other variables) and technology use as a predictor of achievement *gains* (more difficult to show, because the analysis controls for prior achievement and related variables). If we look at residual gains in test scores we, to some extent, control for any prior advantage that computer users might have had in terms of achievement. For other approaches to reporting test score changes see Russell (2000).

Within schools, residual gains on test scores were also related to their computer capability. Those characterized as having higher software capability gained more, on average, than others within their same school.

Table 5. Student Within-School Test Score Gains, by Software Capability

Students within their school characterized as having…	Mean residual test score gain	N	Effect Size
Low software capability	-.05	11157	
High software capability	.06	11331	.18
Total	.00	22488	

Note: Effect size is computed based on the standard deviation for 1999 test score index, .60. This difference is statistically significant, $p < .001$.

The table shows the gain scores of students compared to others within their school based on their reported software capability. These scores place high software capability students within each school, on average, at the 52nd percentile and low software capability students at the 48th percentile, in terms of gains. In this case, a small percent of this many students is a substantial difference

Together, tables 4 and 5 demonstrate that, within schools, it is the students who have more software capability who scored higher on 2000 tests and who *gained more* on tests from 1999 to 2000, controlling for prior achievement.

Discussion

Without losing sight of the larger numbers of students involved in larger schools, students in smaller schools are less likely, using percents of students instead of counts, to have computers at home. Because smaller schools also scored lower on ITBS/TAP tests overall, this creates an inverse relationship between school-only computer use and achievement. On balance, higher performing students tend to use computers more at home than at school. While this may point to the importance of home computing for higher achieving students, it does not mean use at school produces lower test scores.

Students from poorer communities tend to rely more on computers at school. Students from higher income communities use computers more at home. One could argue that the relationship between home use and test scores is entirely due to SES. However, this would not account for low income students with computers at home scoring higher than high income students with no computers at home. It would also not explain the substantial relationship between home use and test scores that appear, even when we control on SES.

When we examine students' *software capability* scores, which in effect allows us to *combine* the effect of computer use at home and at school, we see positive relationship to student test scores and test score gains. Given that home computer use seems to be more closely associated with achievement and computing proficiencies than is school use, even controlling on income, conclude for now that lack of use at home is probably a more substantial barrier to achievement and the development of computing proficiencies than lack of access at school.

We must caution that higher performing students who use computers at home are likely benefiting from a combination of conditions, while low performing students probably see substantially less home use, but also perhaps ineffective school use, and less favorable learning conditions at school and home. Prior research has shown that lower achieving students in particular tend to use technologies that focus on skill or drill games with the objectives of remediation and mastery of student skills. Future analyses will include more attention to pedagogical differences among teachers and to differences in prior achievement within schools.

REFERENCES

Becker, H. & Ravitz, J. (1998). The Equity Threat of Promising Innovations: Pioneering Internet-Connected Schools. *Journal of Educational Computing Research*, *18*(4).

Becker, H., Ravitz, J. & Wong, Y. (1999). *Teacher and teacher-directed student use of computers and software.* Report #3. Teaching Learning and Computing: 1998 National Survey. Irvine, CA: University of California at Irvine, Center for Research in Information Technology in Organizations. Available: http://www.crito.uci.edu/TLC

Ravitz, J. & Mergendoller, J. (2002). Technology use and achievement in Idaho schools: A state wide study of schools, teachers and students. Report commissioned by the J.A. & Kathryn Albertson Foundation. Novato, CA: Buck Institute for Education.

Russell, M. (2000). Using expected growth size estimates to summarize test score changes. Practical Assessment, Research & Evaluation, 7(6). Available online: http://ericae.net/pare/getvn.asp?v=7&n=6.

Weglinsky, Harold. 1998. Does It Compute? The Relationship between Educational Technology and Student Achievement in Mathematics. Princeton, NJ: ETS Policy Information Center. Available online: http://www.ets.org/research/pic/technology.html.

NOTES

The authors gratefully acknowledge the funding of the J.A. & Kathryn Albertson Foundation, as well as the contributions of David Pasta for their helping us to think about these issues, but the authors take responsibility for all the contents.

The Buck Institute for Education (BIE) is a research, materials development, and school change organization. Current projects are focused on high school curriculum development in the social sciences, teacher training in the use of problem- and project-based pedagogy, and research on the effectiveness of our materials and instructional approaches. Founded in 1987 and located in Novato, California, BIE is a not for profit organization governed by a Board of Directors. BIE receives permanent funding from the Leonard and Beryl Buck Trust. For additional information please browse http://www.bie.org.

The J.A. & Kathryn Albertson Foundation is engaged in programs and proactive initiatives to improve education in Idaho, pre-K through 12th grade. http://www.jkaf.org

For more information or further discussion, please contact:

Jason Ravitz <Jason@bie.org) / 18 Commercial Blvd. / Novato, CA 94949 / 415-883-0122 x 310