OPPORTUNITY ONE – TECHNOLOGY INITIATIVE EVALUATION BY THE BUCK INSTITUTE

PRESENTED TO THE J.A. AND KATHRYN ALBERTSON FOUNDATION

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INTRODUCTION

In making investments in Idaho through the Opportunity I initiative, the J.A. & Kathryn Albertson Foundation has acknowledged the hopeful promise of technology and also the need to assess the impacts of technology in classrooms. This report interprets data about student and teacher technology use to portray what is happening in Idaho classrooms and to provide guidance for future funding decisions. It brings together several data sets including a statewide Idaho School Technology Inventory, standardized tests of student achievement (ITBS/TAP), and a teacher survey that has been used in national studies of teacher pedagogy and technology use.[1]

We synthesize findings about data sets and draw attention to patterns of technology use and achievement in Idaho. We describe basic patterns of computer use and achievement that suggest higher-achieving schools and students use computers more than lower achieving schools and students. We then draw comparisons between students, teachers and schools that have similar characteristics to see if technology use is associated with student achievement, with other things being equal.

The Promise of Technology

Across the country the Internet and “office” or “productivity” related software tools have become primary uses of computers in schools, taking on as much importance as self-instructional, self-grading software involving games and tutorials. There has also been a proliferation of subject-specific applications, such as Accelerated Reader. With each new tool comes the possibility of new teaching methods and the ability to seek different objectives for learners.

It is clear from prior studies, teachers in a variety of schools tend to use technology more with higher-achieving students (Becker & Ravitz, 1998). In this context, it is not terribly difficult to argue that technology is a tool for accomplishing tasks more easily, for communicating with others, for creating products, and for self-instruction and entertainment. However, if one is to hold technology accountable to its promise, one would want to find that among students with similar backgrounds and prior achievement levels, those who use technology most intensively achieved more or gained more on yearly achievement tests than less frequent and sophisticated technology users. This report explores this possibility in a variety of ways. The specific research questions addressed, and the location of the relevant findings in the report, appear on the following page.

Research Questions

The research questions addressed in this report are:	The answers are found in:
1. How do schools, teachers and students differ overall -- in their use of technology and in patterns of achievement and gains on test scores?	School descriptive data (*Part 1, page 7)* Teacher descriptive data (*Part 2, page 13)* Student descriptive data (*Part 5, page 29*)
2. Do schools where **teachers as a whole** report more technology access, more capability to use technology, and more technology use have greater year-to-year test score gains than schools with teachers reporting less technology access, capability and use?	School level comparisons, based on index scores for all teachers *(Part 3, p. 23)*
a. Do schools where **math teachers** use more technology have higher math test scores or greater gains on math tests?	School level comparisons, based on index scores for math teachers only *(Part 3, p. 23)*
b. Do schools where **English teachers** use more technology have higher scores or greater gain on reading or language arts tests?	School level comparisons, based on index scores for English-Language Arts-Reading teachers only *(Part 3, p. 23)*
3. Do schools where **students** report more software capability have higher test scores in 2000, or greater test score gains from year-to-year than schools where students report less software capability?	School level comparisons, based on index scores from student survey *(Part 5, p. 29)* Within school comparisons, based on index scores from student survey *(Part 6, p. 31)*

Key Findings

The following table provides a summary of key findings by report section.

PART	KEY FINDINGS
PART 1. SCHOOL DATA *(Begins on p. 7)* We describe how school size and family income are related, and how schools differ in achievement and technology use.	• 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. 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. • For 8th grade schools, there is some evidence that it was the smaller schools that gained more on ITAP from 1999 to 2000. • Using percentage of student users as a measure, there is a negative relationship between use of computers at school and schoolwide 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.[2]

PART	KEY FINDINGS
PART 2. TEACHER TECHNOLOGY USE *(Begins on p. 13)* We describe patterns of technology access, use and capability among teachers based on grade and subject taught, gender, and the perceived prior achievement of their students. This section includes data from fourth grade teachers that does not appear in other sections of the report.	• Teachers in 4th grade have several computers in their classroom more often than 8th and 11th grade teachers. They report using word processing software with their students as often as secondary teachers do. • The most frequently used software by teachers included word processing, World Wide Web, and CD-ROM Encyclopedias. A substantial proportion of 4th grade teachers also used Accelerated Reader and games. Teachers of older students were more likely to use software tools like databases. • The most frequently listed objective for software use with students was "finding out about ideas and information;" this was selected by 70% of teachers. About 30% of teachers listed students' analyzing information, and becoming better writers, as well as mastering academic skills and learning computer skills. • Teachers who report teaching higher achieving students use technology more than teachers who report teaching lower achieving students. • Female teachers report having passed the Idaho Technology Competency Assessment more frequently than male teachers; they also score higher on other computer-related measures. • Teachers requested future training on integrating technology in the curriculum, managing students' use of technology, and learning advanced applications including the World Wide Web, multimedia and digital imaging. They were less interested in receiving training on basic PC and word processing skills.

PART	KEY FINDINGS
PART 3. TEACHER TECHNOLOGY USE AND STUDENT ACHIEVEMENT *(Begins on p. 23)* In this section we compare the test score gains made by schools based on schoolwide teacher technology use measures.[i] We also make comparisons based on technology use by math and English teachers. *(Begins on p. 25)*	• There are substantial and statistically significant effect size differences in the *achievement gains* of schools based on whether their teachers were characterized as high or low technology-using. These differences were found using an overall index of teacher technology use and also for two of the subcomponents of this index -- teacher software use with students and teacher software capability. The effect sizes ranged from .36 for teacher software capability to .50 for software use with students. Converted to gain percentiles, this places high technology schools at about the 55th percentile, or five percentile points above the mean gain; while low technology schools gained at the 45th percentile, or five percentile points below the mean gain score. • Subject-specific analyses varied depending on the size and grade of the school. In larger 11th grades, math teacher computer use is associated with increases in test scores among students, while less teacher computer use was associated with larger gains in 8th grade schools and in smaller 11th grade schools. Computer use by English-Language Arts-Reading teachers is associated with smaller gains, although computer use by 11th grade teachers is associated with higher 2000 test scores in general.
PART 4. STUDENT COMPUTER USE AND SOFTWARE CAPABILITY *(Begins on p. 27)* We look at student computer use at home and at school, and where they seem to develop computer-related skills.	• Students who use computers both at school <u>and</u> at home have the highest self-reported software capability. • Students in smaller schools who have access to computers in both locations report equivalent capability to use software as students in larger schools.

PART 5. STUDENT SOFTWARE CAPABILITY AND SCHOOLWIDE TEST SCORES *(Begins on p. 29)* We look at the relationship of schoolwide achievement and achievement gains to students' reported software capability.	• There are small differences in schoolwide achievement and test score gains based on the average computer capability of students in each school. These differences are not statistically significant but they are consistent with our other findings. Schools with students who have more computer skills appeared to be higher achieving and to gain more on year-to-year achievement measures.
PART 6. WITHIN-SCHOOL STUDENT SOFTWARE CAPABILITY AND ACHIEVEMENT *(Begins on p. 31)* In this section we show how students who use technology perform relative to others <u>in their own school</u>.	• Comparing students within schools, it is students who have higher software capability who score higher on tests and who gained more, on average, from 1999 to 2000. These findings are statistically significant, $p < .001$. • The effect size for students with higher software capability is .35, or about a one-third standard deviation on the 2000 tests. These scores place high software capability students, on average, at the 57^{th} percentile and low software capability students at the 44^{th} percentile. • The effect size for students with higher within-school software capability is .18 for achievement gains from 1999 to 2000. These scores place high software capability students within each school, on average, at the 52^{nd} percentile and low software capability students at the 48^{th} percentile.

<u>Note</u>: Appendix A provides a summary of methods and variables used in this study.

PART 1. SCHOOL DATA

In this section we provide an overview of the pattern of technology use and achievement across Idaho's schools. Later we look more closely at differences in teacher and student technology use and their relationship to achievement, but some general patterns are worth noting first.

Basic Differences, by Size and Grade

Most of Idaho's schools are small and in low income, rural areas. However, most of the Idaho's students are in a few, more urban, areas (Table 1).[ii] Because larger schools have higher median incomes, school size is a good indicator of the resident family incomes. [iii] To categorize schools by size, we use the same criterion used for athletic competitions because this criterion is well known around the state.

Table 1. Numbers and Percentages of Schools and Students, by School Grade and Size

	School Size Category (Number of students in all grades)					
8th grade	Less than 150	150-349	350-799	800-1249	1250 or more	Total
Number of schools	34	57	45	12	-	148
Number of students	515	2867	8259	3240	-	14881
Average # of students per school	15	50	194	280		
Percent of schools	22	39	31	8	-	100
Percent of students	3	19	56	22	-	100
11th grade						
Number of schools	37	55	31	19	11	153
Number of students	476	2207	3494	5041	3975	15193
Average # of students per school	13	40	113	265	361	
Percent of schools	24	36	20	12	7	100
Percent of students	3	15	23	33	26	100

Computer Use and Student Achievement

Compared to smaller schools, larger schools have a higher proportion of students who use computers at home, and a smaller proportion that use computers at school. At the same time, there are relatively fewer computers per student in the larger schools. Idaho's smallest schools have close to one computer for every two students, while the largest schools have closer to one computer for every five students. Among 11th grade students, for the largest schools, 85% reported using computers at home, but only 50% reported using computers at school.

Table 2. 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[iv]	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.

Looking at Table 2, it is apparent that family income is related to school size. Patterns of computer use at home generally follow school size (and income) patterns. Over 80% of students in the largest schools use computers at home, compared to less than 70% of students in the smallest schools. Patterns of computer use at school are related to the school computer-student ratio. Schools with more computers per student (e.g., smaller schools) enrolled a greater percentage of students who use computers at school. In the 8th grade, three-fourths of the students in the smaller schools use computers at school, compared to half of the students in the largest 8th grade schools.

Patterns of school achievement are directly related to home computer use and family income and inversely related to school computer use. This relationship persists, even controlling for school size.[v] Overall 2000 school achievement is reported on Table 2 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 direct relationship to the size of the school. 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 (Appendix B). 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.

Because of the relationship of school size and family income to school computer use, 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 also 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.

1999-2000 Change in Overall School Achievement

Eighth and 11th grade students in this study completed standardized achievement tests in 1999 and again in 2000. Given the way in which such tests are constructed, it is to be expected that 11th grade students will score higher (and know more) than 8th grade students. Even over the course of a single year, in theory, the scores of students who engage in their schoolwork are expected to rise, reflecting the acquisition of additional knowledge and skills.[vi]

Table 3 displays schoolwide achievement and 1999-2000 changes in school achievement by school size and grade. It uses z-scores to compare schools on a common metric. As noted earlier, z-scores are based on a common standard deviation and mean. To interpret this table, first consider that the average school had overall 2000 school achievement scores (one point in time), raw change standardized z-scores, and standardized residual change z-scores near 0.00. (This is seen in the rows labeled "All 8th grades," "All 11th grades," and "Both grades.")

Now consider the nature of the scores displayed in the three right columns of Table 3. The first column, labeled, "Overall 2000 **School Achievement,**" shows the same relationship between school size and achievement found in Table 2. The average achievement scores of smaller schools are considerably lower than that of larger schools, for both 8th and 11th grade students. For example, schools with less than 150 11th grade students have a score of -0.79, indicating that the average achievement of their students in 2000 was less than that of students in the average school. In contrast, schools with 1250 or more 11th grade students had a score of +0.67, and consequently, had greater achievement in 2000 than the average school with 11th grade students.

Next, consider the column labeled, "Overall **Raw Change** 1999-2000 School Achievement." These data show how much a school's overall achievement increased or decreased from year to year. It is created by subtracting a school's 1999 achievement score from the same school's 2000 score and expressing this difference in z-scores. Because these are z-scores, a negative score does not mean a school lost points on the test. In fact, most schools gained. A negative score indicates the extent to which a school's overall gain in achievement was less than average from 1999 to 2000; a positive score, in contrast, indicates the extent to which overall achievement score gained more than others. A score of zero means the school gained the same as an "average" school, or that it was at the 50th percentile in terms of gain. As can be seen, smaller schools with 8th grade students and larger schools with 11th grade students had higher achievement gains from 1999 to 2000 than the average school.

It appears that smaller 8th grade schools gained more than others, while the reverse is true for 11th grade schools. Here larger schools gained more (although there was a slight dip for 11th grade schools with 800-1249 students). Gains on the language arts test were substantially smaller than gains on the mathematics and reading tests (Appendix C.)

Another way to look at gains is to examine residual change scores.[vii] These scores indicate how much higher or lower students scored in 2000, *compared to what would have been predicted based on their scores in 1999*. This analysis technique can help remove the effect of lower performing schools not gaining as much as higher performing schools or a possible "ceiling effect" by anticipating less gain for higher achieving students.

The rightmost column on Table 3 uses residual change scores to compare 1999 and 2000 overall school achievement. Note that for 8th grade schools, the residual change scores remain close to 0. This indicates that the size of 8th grade schools was not related to patterns of rising or falling achievement. The difference between 1999 and 2000 achievement for all school size categories was about the same as the average school. For schools with 11th grade students, there is a fairly linear trend in the raw change scores that is shown even more clearly in the residual change scores: the average achievement gain of students in larger schools is greater than that of students in smaller schools. (Appendix B and Appendix C provide comparisons by subject.)

Table 3. Schoolwide Achievement and Gains, by School Size

Grade	School size (sports categories)	Overall 2000 **school achievement** (z-score within grade)*	Overall **raw change** in 1999-2000 school achievement (standardized raw change z-score within grade)	Overall **residual change** in 1999-2000 school achievement (standardized residual change z-score within grade)
8	< 150	-0.48	0.16	-0.01
	150-349	0.03	0.05	0.07
	350-799	0.19	-0.11	-0.03
	800-1249	0.44	-0.23	-0.05
	All 8th grades	0.00	0.00	0.01

11	< 150	-0.79	-0.15	-0.46
	150-349	0.01	0.02	0.09
	350-799	0.35	0.05	0.24
	800-1249	0.55	-0.07	0.25
	1250+	0.67	0.35	0.60
	All 11th grades	0.00	0.00	0.05
Totals	< 150	-0.64	0.01	-0.24
	150-349	0.02	0.04	0.08
	350-799	0.25	-0.05	0.08
	800-1249	0.51	-0.13	0.13
	1250+	0.67	0.35	0.60
	Both grades	0.00	0.00	0.03

*This is an index score combining Language Arts, Mathematics, and Reading Achievement scores. The residual gains and the raw gain scores were correlated (r = .65).

Summary of School Data

Taking into account school size and prior achievement, some schools score *higher than would be expected* for their size and the income. The smaller schools with 8th grades made larger raw gains than larger schools with 8th grades. The largest 11th grade schools gained more across all three tests, even when we used residual change scores to control for their higher 1999 scores.

Smaller schools, in general, have a higher proportion of school users and more computers per student. They also have lower incomes, less home computer use, and lower test scores overall. Because of these associations with school size, we have to look *within school size categories* to find out the effect of schoolwide computer use.

If higher scoring schools (controlling for size and grade) are using more technology, then technology might be making a difference. If technology has little or no relationship to achievement (after controlling for size and grade) we have to look elsewhere to explain the causes of higher achievement. The same logic applies to trying to relate changes in achievement test scores to student and teacher technology use.

In the following section of this report (Part 2) we describe the patterns of technology access and use by teachers of different grades and subjects. Once we have explored this, we will examine the relationship of schoolwide teacher computer use and schoolwide achievement and year-to-year changes in school achievement (Part 3).

PART 2. TEACHER TECHNOLOGY USE, BY GRADE AND SUBJECT

This section examines teachers' access to technology, their professional uses of technology and their reported capability to use different types of software. We also describe variations in computer use with students by subject taught. An overall score based on these measures is used later in this report to determine the extent to which achievement scores and changes in year-to-year achievement scores might be related to teacher computer use.

Teachers have different goals for instruction and use different strategies (including using technology) to pursue these goals. Grade and subject taught are key variables related to a teacher's practices and technology use. Teachers' technology use is also related to the access they have to technology, the availability of quality software, and their instructional objectives for using computers. The gender of the teacher can also be related to teaching practices and technology use, even for teachers teaching the same subject and grade.

This part of the report includes data from 4th grade teachers, in addition to the 8th and 11th grade data presented in the previous section.[viii] This allows us to consider the extent to which technology uses are "developmentally" different – due more to the age of the student than to school or teacher characteristics or the location of the computer.

Prior research has shown that it may be easier to incorporate technology into the curriculum in "non-core" subjects. These are subjects where teachers more frequently use project-based curriculum, and where students generally have better access to computers. English is also a subject where prior research has shown that computers tend to be used frequently by students for writing (especially in high school) and where teachers more often assign long lasting projects (Becker, Ravitz, & Wong, 1999; Ravitz, Becker & Wong, 2000).

Twenty-five percent of the secondary teachers in the study identified themselves as teaching a subject other than one of the core academic subjects, or computers.[ix] We combined these teachers into a "Vocational-Business-Other" category accounting for one-third of the male teachers and one-fourth of the female 11th grade teachers. English-language arts and reading teachers account for one-third of the female teachers at both grades, but 10% or less of the male teachers. (Appendix D shows the breakdown of subjects taught for male and female teachers at the 8th and 11th grade levels.)

Teacher Technology Access

Nearly all of the teachers in Idaho have access to a classroom desktop computer connected to the Internet for their own use. A majority of these teachers (97%) use email and the World Wide Web (WWW). Just 3% of teachers say they would like access to email and WWW but do not have a classroom computer. Fewer still say they have a classroom computer but do not use it (Table 4).

Table 4. Internet-connected Computers, for Teacher Use in the Classrooms

	Number of Teachers			
Classroom computer access	Don't have and don't want	Don't have but want	Have and don't use	Have and use
At least one computer with World Wide Web connectivity	3	31	24	1022
Teachers' computer station with email	6	43	23	1298

Note: Data from grades 4, 8 and 11 are combined on this table.

The greatest unmet demand by grade was among 4th grade teachers, and here only 5% of the teachers reported that they did not have but wanted email. Only 1% of the 4th grade teachers made a similar comment about WWW access.

Classroom Computers Available for Student Use

All of the 4th grade teachers in the study report having at least one classroom computer available for student use. More than 90% report they have two or more classroom computers. In secondary grades, 20% of the teachers do not have a computer in their class for student use, and 44% say they have only one computer for their students.

Compared to teachers of academic subjects in the 8th and 11th grades, 4th grade teachers have a sizable number of computers in their rooms. They report a median of 4.00 classroom computers, and a mean of 4.13 classroom computers. Compared to Table 5, showing data for 8th and 11th grade students, these figures suggest that 4th grade students have better classroom computer access than 8th and 11th grade students in science, math and social studies classes.

Table 5. Number of Computers in Classroom for Student Use, by Secondary Subject

	Number of teachers		Median number of computers			Mean number of computers		
Subject Taught	8th grade	11th grade	8th grade	11th grade	Total	8th grade	11th grade	Total
English-Language Arts-Reading	49	53	3.0	3.0	3.0	3.7	3.3	3.5
Science	38	47	1.5	3.0	2.0	2.3	4.3	3.4
Math	48	56	1.0	2.0	1.5	2.0	2.8	2.4
Social studies	44	47	2.0	1.0	2.0	2.8	2.2	2.5
Vocational-Business-Other	41	53	4.0	10.4	6.9	7.5	10.2	9.0
Computers/Technology	26	25	25.0	22.0	24.0	23.5	21.1	22.3
Total	246	281	2.0	3.0	3.0	5.7	6.1	5.9

Table 5 also shows that in secondary schools, teachers of non-core academic subjects (Computers, Vocational-Business-Other) have better access to computers for student use. Next we examine teachers' capability to use computers and the extent of their computer use for professional -- as opposed to instructional -- purposes.

Teacher Software Capability and Professional Computer Use

Prior research has shown that teachers who do not use technology for their own professional purposes are less likely to be skilled in computer use and are less likely to use computers with their students. It is also generally far easier for teachers to use technology on their own rather than to integrate computers into classroom instruction (Ravitz, 1999).

One indication of teachers' software capability is whether they have passed the Idaho Technology Competency Assessment (ITCA). Table 6 displays the percentage of teachers reporting they have passed the ITCA. In fourth grade, 90% of male and female teachers report they have passed this assessment. In secondary schools, across each subject, more female teachers have passed the ITCA requirement than males. Eighth grade English teachers and social studies teachers in both grades 8 and 11 were least likely to report they had passed the ITCA.

Table 6. Percentage of Teachers Passing Idaho Technology Competency Assessment (ITCA)

	% teachers passing ITCA		
Subject Taught	Male (N=465)	Female (N=434)	Total (N=899)
Fourth grade – All	90%	90%	90%
English-Lang Arts-Reading	64	86	81
Science	84	93	87

Math	81	92	86
Social studies	66	76	69
Voc-Business-Other	76	93	83
Computers/Technology	97	93	95
Total	77	89	83

Teachers who indicated that they had passed ITCA requirements also reported higher levels of computer proficiency on a survey distributed as part of this evaluation. There was, however, one exception. Male English teachers reported higher capability scores, regardless of whether or not they had passed the ITCA.

Table 7 displays 8th and 11th grade teachers' desires for additional technology training. Overall, teachers were most interested in receiving training in technology integration and managing students' use of technology. Training was also sought for advanced applications like creating multimedia, using the World Wide Web, and digital imaging. This would indicate that most teachers feel they have mastered basic computer competencies. They were least interested in receiving further training in basic software skills.

Table 7. Interest in Technology Training Topics, Secondary Teachers

	% Teachers Responding				
Training Topic	None	Start from scratch	Just a refresher	Advanced course	Total
Creating multimedia	18%	29%	27%	26%	100%
Integrate technology daily	18	18	30	34	100
Using the WWW as an instructional resource	29	10	34	27	100
Digital imaging	17	29	29	25	100
Managing students and activities	20	24	29	28	100
Databases	21	23	37	19	100
Presentation software	28	15	32	25	100
Spreadsheets	31	12	36	20	100
Word processing	55	2	22	22	100
Basic PC operations	56	3	29	12	100

Note: The data on Table 7 combine responses from 8th and 11th grade teachers. Appendix E shows responses to training topics for each grade (4, 8, and 11).

Software Use with Students

Teachers report substantial differences in the software they use with students, according to the grade and subject they teach. We asked teachers how often they require student computer use for their assignments. These results are shown in Appendix F. Teachers of 11th grade require use more often than teachers of 8th grade. The subjects where teachers most frequently require students to use computers, besides computer classes (not shown), are vocational-business-other classes. In the academic subjects, English teachers and social studies teachers require computer use more often, while science and math teachers require computer use less often.

We also asked teachers to report how much they used different types of software in their lessons over the course of the school year. They responded by indicating whether they had used software in zero lessons, one or two lessons, three to nine lessons, or ten or more lessons.[x] Table 8 shows the percentage of teachers who used different types of software three or more times, by grade.

Accelerated Reader is in use almost universally in 4th grade. The next most prevalent types of software use reported by teachers for fourth graders are word processing and game software. CD-ROM Encyclopedia use and Accelerated Reader use are also far more prevalent in 4th grade. When these are used in secondary schools, it is more often among teachers of 8th grade students. Secondary teachers most often used word processing and the World Wide Web with students, but no more frequently than elementary teachers. It's important to keep in mind that a large proportion of 4th grade teachers teach self-contained classes, and this makes it easier to rotate students onto the computer over the course of the day.

Overall it appears younger students are more often using Accelerated Reader, games, and CD-ROMs. Most of the "tool" uses displayed in Table 8 are more common in 11th grade, although word processing is prevalent at all grades. Use of the World Wide Web in lessons three or more times was reported by over half the teachers in all grades.

Table 8. Percentage of Teachers Reporting Students Used Software Three or More Times, by Grade Taught

Percent of teachers using each type of software three or more times….

Grade	N	Accelerated Reader	Word Processing	Games	World Wide Web	CD-ROM Encyclopedia
4	304	99%	84%	75%	57%	56%
8	397	39	60	22	51	37
11	1030	05	66	14	57	37

Grade	N	Simulations	Presentation	Data Visualization	Graphics/ Printshop
4	304	35%	25%	15%	25%
8	397	23	22	23	17
11	1030	32	30	34	22

Grade	N	Databases	Accelerated Math	HyperCard or Multimedia	Email
4	304	09%	19%	18%	12%
8	397	13	08	07	10
11	1030	23	05	11	18

"Tool" computer use in the classroom refers to using software that was not developed to be instructional in a formal sense. Educational games, Accelerated Reader, Accelerated Math, and in some ways data visualization tools are designed to be used for instruction. The rest of the applications listed in Table 8 are viewed as “tool” or “productivity” applications. These types of software serve broadly useful purposes that can be tied to instruction but need not be.

Appendices G and H display interesting patterns of software use by grade and subject area. English-Language Arts-Reading teachers reported using the World Wide Web in three or more lessons with 11th grade students more frequently than 8th grade English-Language Arts-Reading teachers (78% vs. 58%). Eleventh grade math teachers reported using spreadsheets three or more times with students more frequently than 8th grade math teachers (82% vs. 39%). Eleventh grade science teachers were twice as likely as 8th grade science teachers to use databases in three or more lessons (29% vs. 14%) In summary, tool computer use is more prevalent in the 11th grade while games and subject-specific computer use is more prevalent in the 4th and 8th grades. These general patterns of use by subject are mirrored in the responses of teacher concerning how often they tended to require students to use computers for work in their classes (Appendix F).

Objectives for Software Use with Students

The objectives given for student computer use provide a good indication of what the teacher is trying to accomplish with technology. Objectives of skill remediation are generally accomplished with games and tutorial software, while the objectives of analyzing information are associated with use of spreadsheets, word processing, databases, and the World Wide Web. If computers are to have an impact on student learning, this impact will be related to the objectives teachers are trying to achieve. We asked teachers to select their three most important objectives for student computer use. These data are displayed in Table 9.

Eleventh grade teachers more often chose the objectives of analyzing information and finding out about ideas and less often chose objectives involving mastery of academic or computer skills. This suggests that the more challenging objectives for computer use are espoused by teachers of older students. Teachers of younger students reported objectives for student computer use that seemed to be more skills-oriented, including the desire for students to become skilled at word processing and computer skills, and helping students to become better writers.

Table 9. Percentage of Teachers Placing Each Objective in Their Top Three, by Grade Taught

Top three objectives for student computer use	Percentage choosing, by grade		
	4th	8th	11th
Finding out about ideas and information	73%	68%	70%
Learning word processing skills	53	28	21
Learning computer skills	49	35	33
Analyzing information	7	39	49
Mastering academic skills just taught or remediating skills	40	30	31
Presenting information to an audience	22	35	33
Becoming better writers	35	26	25
Learning to work collaboratively	14	21	22
Communicating electronically with other people	3	5	8
N	307	420	663

Appendix I displays objectives for student computer use by grade and subject taught. Math teachers, by far, most frequently listed mastery of skills as one of their top objectives (61%). This compared to 19% of English teachers and only 31% of teachers overall. This probably reflects the fact that many math teachers see their job as teaching students math skills, rather than math analysis. It may also reflect the availability of mathematics drill and practice software, particularly in 8th grade. Among math teachers, 70% of 11th grade teachers had the objective of analyzing information, compared to 57% of 8th grade math teachers.

There is a similar pattern in English. Eighth grade English teachers more frequently listed learning word processing skills as one of their three objectives compared to 11th grade English teachers (49% vs. 31%). Eleventh grade English teachers reported helping students become better writers as one of the top three objectives more frequently than 8th grade English teachers (90% vs.72%)

In science, 52% of the 11th grade teachers reported presenting information to an audience as one of their top three objectives for student computer use compared to 37% of 8th grade science teachers. Finally, a greater proportion of 11th grade social studies teachers selected helping students improve their writing and analyzing information as one of their top three objectives for computer use compared to 8th grade social studies teachers (22% vs. 10% and 62% vs. 49%). In contrast, a greater proportion of 8th grade social studies teachers selected the goal of learning computer skills, compared to 11th grade social studies teachers (35% vs. 16%).

Teachers' Perceptions of Student Achievement and Technology Use

Teachers are fairly accurate judges of their students' abilities and performance. Their estimation of students' prior ability, averaged across the school, correlated well with the students' standardized achievement scores ($r > .4$). Teachers' perceptions of students' prior achievement are related to teachers' instructional practices (although teachers' perceptions of prior achievement are not as closely related to teachers' beliefs). Even after controlling for subject taught, teachers use computers more frequently for drill-and-practice and other tutorial/remedial purposes, and espouse skill-based, mastery objectives more frequently when teaching classes perceived to be lower performing. In contrast, students perceived to be higher achieving are more likely to be given problems for which there is no easy solution.

As noted on Table 10, almost 39% of the teachers in our sample reported that they never give "below average" classes problems for which there is no easy solution. In contrast, only 21% of the teachers who perceive they are teaching students of a "very high" academic level never assign such difficult problems.

Table 10. Challenging Problems for Students by Academic Level of the Class

	Percentage of teachers reporting students work on problems with no easy solution in their class					
Academic level of class (teacher-reported)	Never	Sometimes	1-3 times per month	1-3 times per week	Almost everyday	Total
Below average	38%	36%	13%	9%	3%	100%
Average	27	43	18	8	3	100
Above average	30	39	17	12	2	100
Very high	21	39	19	15	5	100
All	29	44	18	13	2.	100

Table 11 uses standardized z-scores to display the relationship between teachers' perceptions of the academic level of the class they teach and teacher software capability, and frequency of computer use with students. There is a general trend for teachers who perceive their students as higher achieving to have greater software capability and to use computers more with students. This suggests there is not only a digital divide, but an instructional divide between students perceived by their teachers as high- and low-achieving.

Table 11. Teacher Computer Scores by Perceived Achievement Level of Students

Academic level of class (teacher-reported)	Teacher software capability (standardized z-scores)	Overall use with students (standardized z-scores)
Below average	-0.10	-0.15
Average	-0.05	-0.05
Above average	0.05	0.07
Very high	0.12	0.14
Total	0.00	0.00

Summary of Teacher Data

Table 12 provides a useful summary of secondary teachers and their overall computer use. Looking first at software capability, computer/technology teachers have the highest scores, suggesting they are the most computer capable teachers. Next, teachers of Vocational-Business-Other classes report the most student use overall, with our measure seeming to measure variety more than depth of experience with any one piece of software.

Among the academic subjects, English teachers most frequently require students to use computers and indicate that, compared to teachers of other subjects, computers have had the most importance over the last five years of teaching. Math teachers report the least student computer use, and they ranked last among subject areas in the importance they ascribed to classroom computer use. (These are broad averages and do not reflect well or poorly on individual teachers who are or are not making extensive use of computers).

Of the academic subjects, social studies teachers reported having their students use more software even though the teachers gave themselves the lowest scores on software capability. This suggests that there is a variety of software available for use in social studies projects.

The next three columns, labeled Professional use, "Tool" use with students and overall use with students, present data on three different types of computer use. Professional use includes uses that support the teacher's professional role (word processing, email), but are not directly used for student instruction. We again find that computer and technology teachers use computers the most frequently for professional uses, although female Vocational-Business-Other teachers and female science teachers are also heavy users of computers for professional purposes. In contrast, mathematics teachers and male English-Language Arts-Reading teachers use computers for professional purposes the least.

"Tool" computer use reflects using the computer as a tool to perform tasks that are impossible or more difficult without it. Once more, computer/technology teachers stand out as the teachers who most frequently use computers with students for these purposes. In contrast, mathematics teachers are the least frequent users of computers as learning tools. The same pattern of results appears in the next column labeled Overall use with students. This column includes use of subject-specific software like Math Blaster and Accelerated Reader. Computer/technology teachers use computers the most frequently to support student learning, and mathematics teachers use computers the least frequently.

The final column labeled Importance of computers over five 5 years presents data describing the importance teachers ascribe to computers over a five-year period. Again, we see the same pattern: Computer/technology teachers ascribe the most importance to computers and mathematics teachers ascribe the least importance to computers.

The largest differences among secondary teachers are probably a result of subject and grade taught. Within subject and grade taught, however, we note that there are differences in use of technology by women and men, and by teachers who perceive that they have higher or lower achieving students.

Table 12. Secondary Teacher Software Capability and Use, by Subject Taught and Gender

Subject taught	Number of teachers		Teachers' Z-scores: Computer capability		Professional use		"Tool" use with students		Overall use with students (includes games and subject specific use)		Importance of computers over 5 years	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
English-Language Arts-Reading	51	169	-.13	-.34	-.29	.05	-.01	-.01	-.10	-.03	-.01	.03
Science	113	53	.08	.27	.00	.34	.11	-.03	.11	-.05	-.11	-.01
Math	100	108	-.23	-.01	-.50	-.21	-.85	-.78	-.60	-.56	-.51	-.27
Social Studies	102	53	-.36	-.17	-.19	.21	.03	.19	-.09	.14	-.30	.07
Vocational-Business-Other	136	105	.16	.28	.00	.30	.15	.53	.07	.43	.12	.36
Computers/technology	34	33	1.06	.87	.76	.35	1.19	.98	1.11	.90	.92	.89
Total	537	521	.00	-.01	-.11	.11	-.02	.02	-.03	.03	-.09	.09

PART 3. TEACHER TECHNOLOGY USE AND STUDENT ACHIEVEMENT

We now move from descriptions of teacher technology use to examining the relationship of this use to student achievement. In the first section of this part we focus on overall schoolwide technology use by teachers and the relationship to student achievement. We reason that so much student use of computers takes place outside of academic classrooms that an overall impact may exist beyond use by teachers in any one subject. For example, word processing outside of English classes could plausibly contribute to language arts skills and would be counted in a schoolwide measure of technology use.

Teachers' Computer Use and Schoolwide Test Scores

Because we do not know which teacher taught which students we have to create a schoolwide teacher use measure for each software and compare schools based on the amount of use of its teachers overall. First we characterize each school -- based on responses from all teachers -- as relatively high or low technology-using schools. These analyses use an overall index that combines teacher professional use, use with students, and teacher self-reported software capability. Achievement is based on the average z-score on all three 2000 tests (Reading, Language Arts, and Math). Gains in achievement are based on the average residual scores from 1999 to 2000 across all three tests. Appendix A provides further details about index construction.

In each case, those schools with higher technology-using teachers made greater gains on test scores from 1999 to 2000. These gains are expressed as mean scores, with the effect size representing the size of the difference in terms of standard deviations. A school that scores one standard deviation above the mean is scoring at the 84^{th} percentile. A school that scores one-half standard deviation above the mean is at the 67^{th} percentile. A school that scores one-quarter standard deviation above the mean is scoring at the 58^{th} percentile.

Findings are consistent across these analyses; schools with teachers and students who have higher technology use or computer capability measures gained more than other schools. In these analyses, we used the standardized residual gain scores, or how much each school scored above or below what would have been expected based on its 1999 scores alone.

While we know that the patterns shown are at a very gross level, the fact that they appear in such a consistent direction is fairly persuasive that something about overall teacher and student computer use is related to greater gains on tests, even controlling for prior achievement. Table 13 shows that schools with teachers who have higher overall computer use indices (includes computer capability, requiring computer use by students, use of different software with students, professional computer use) gained more on ITBS/TAP tests.

Table 13. Teacher Overall Computer Use and Schoolwide Test Score Gains

Schools with teachers characterized as…	Mean residual test score gain	N	Effect Size[xi]
Low technology-using	-.09	63	.39
High technology-using	.15	67	
Total	.04[xii]	130	

Note: The relationship is statistically significant (p<0.2) for smaller 8th and 11th grade schools, but is not significant for larger 8th and 11th grade schools.

The effect size associated with a school having high technology-using teachers is .39. These scores place the average high technology-using school at the 55th percentile, or five percentile points above the mean for all schools. The average low technology-using school gained more than 46% of the schools overall, and was placed four percentile points below the mean of all schools.

Looking just at reported software use with students, Table 14 shows that schools with teachers who use various software types show higher test score gains. This measure combined various uses with students (word processing, presentation software, spreadsheets/databases, email, and games for practicing skills).

Table 14. Teacher Software Use with Students and Schoolwide Test Score Gains

Schools where teachers report…	Mean residual test score gain	N	Effect Size
Low software use with students	-.12	63	.50
High software use with students	.18	67	
Total	.04	130	

Note: The relationship is statistically significant (p<0.2) for smaller 8th grade schools. The relationship can be clearly seen for other grade/size combinations, but is not statistically significant.

The effect size for schools with teachers who use more software with students is .50; their average gain score is at the 57th percentile, or seven percentile points above the mean for all schools. The average gain score for schools using less software with students was at the 45th percentile or five percentile points below the mean for all schools.

Finally, Table 15 shows that schools with teachers who report more software-related skills show higher test score gains. This measure combined self-reported capability on a variety of types of software, including word processing, email, and so on.

Table 15. Teacher Software Capability and Schoolwide Test Score Gains

Schools with teachers who have…	Mean residual test score gain	N	Effect Size
Low software capability	-.07	64	.36
High software capability	.14	65	
Total	.04	129	

Note: $p < .05$.

The effect size for schools with higher teacher software capability is .36, or one-third a standard deviation. This places these schools, on average, at the 55th percentile, or five percentile points above the me333an for all schools. The average gain score for schools with lower teacher software capability was at the 47th percentile, or three percentile points below the mean for all schools. The relationship is present for all four grade/size combinations, but is most strongly present for small 11th grade schools.

In summary, schools with teachers who report more computer and software use, and higher capability to use software, have higher gain scores than other schools. This is based on scores for all the teachers within the school; we recognize that substantial student use may take place outside of the core academic classes. In the next section, we focus on technology use only by teachers of specific subjects that correspond to each of the achievement tests.

Math Teachers' Computer Use and Schoolwide Math Scores

Overall, math teachers use computers less than other teachers (Table 12). Nonetheless, there are still some schools where math teachers use technology more than others. This is determined by aggregating the technology use measures for all math teachers for whom we had data within each school, and splitting the schools into groups according to the technology use of the math teachers. When we compare these two groups of schools, interesting patterns emerge, but only when we look at 8th and 11th grade schools of different sizes.[xiii]

The only grade-size combination where greater technology use by math teachers is associated with higher math test scores in 2000 is among larger 11th grades. In the 11th grade overall, schools with high technology-using math teachers also *gained* slightly more than other schools. However, this pattern was only present for larger 11th grade schools. In smaller 11th grade schools technology use by math teachers is associated with slightly lower test score gains. In 8th grade, *smaller* schools with high technology-using math teachers gained more than other smaller 8th grades. Preliminary analyses that attempt to account for this pattern based on uses of specific software used by math teachers (e.g., data and graphing tools, simulations, games and Accelerated Math) have been inconclusive.

To summarize, if we are looking for an area where technology use by math teachers appears to have a positive impact, it is in the larger 11th grades and the smaller 8th grades. In the other schools, technology use by math teachers seems to be associated with smaller test score gains (See Appendix J for details).

English Teachers' Computer Use and Schoolwide Reading and Language Arts Scores

Similar analyses were done for English-Language Arts-Reading teachers and schoolwide reading and language arts achievement. In the larger 8th grade schools, schools with high technology-using English teachers score higher on the 2000 language arts and reading tests. This pattern does not show up in the smaller 8th grades, where there is little difference in schoolwide test scores based on teacher technology use. In 11th grade, the 2000 scores are higher for schools with relatively low-technology-using teachers.
Looking at test scores gains, computer use is associated with lower gains on tests. This is particularly true in the smaller 11th grades.

Subject-Specific Software Use and Schoolwide Test Scores

We tried to identify particular applications and objectives that might help students learn in each subject area. One obvious candidate for improving reading and language arts scores is Accelerated Reader, although the most frequent use of this software is by fourth graders for whom we do not have test score data. The use of word processing could also be expected to be related to student achievement gains in reading and language arts.

Overall, lower performing schools use Accelerated Reader more and they gain more than other schools on both reading and language arts achievement test scores. However, these schools do not make greater residual gains. The fact that residual gain scores were equivalent for schools with greater and lesser Accelerated Reader use means that while the test scores of lower-achieving schools using Accelerated Reader extensively increased, the test score gains did not exceed those of similar schools that used Accelerated Reader less.

Only among the smallest 8th grades does it appear that Accelerated Reader use could have boosted language arts scores, and possibly the smaller 11th grades on reading scores. Generally, the 1999-2000 achievement gain of schools reporting extensive Accelerated Reader use was less than would have been expected if Accelerated Reader was making a substantial contribution to increased achievement. However, we are looking at schoolwide use, and we do not know if individual students who used this application gained more than others or not.

It appears that schools where teachers reported more student word processing, however, gained slightly more between 1999 and 2000 on reading and language arts tests than schools reporting less student word processing. This pattern is particularly dramatic in smaller 8^{th} grade schools. It is also seen in larger 8^{th} grade schools, but only in language arts.[xiv]

PART 4. STUDENT COMPUTER USE AND SOFTWARE CAPABILITY

This section describes findings from the survey responses of over 30,000 students. It presents patterns of student computer use at school and at home and shows that half of the students in each grade use computers both at home and at school. We also suggest that development of software capabilities occurs in both locations.. The combination of these two findings provides the basis for using software capability as a predictor of achievement in the following sections. Software capability provides a useful indicator of students' overall experience with computers, regardless of the location of use.

Table 16. Computer Use at School and at Home, by Students

		Size of School					
Grade	Location of Use	< 150	150-349	350-799	800-1249	1250+	Total
8	Neither	9%	6%	8%	9%		8%
	Home only	18	18	27	37		27
	School only	20	18	12	8		13
	Both	53	57	53	46		52
		100	100	100	100		100
11	Neither	5	4	7	7	8%	7
	Home only	12	15	23	34	44	31
	School only	20	18	14	9	6	11
	Both	62	63	56	50	42	51
		100	100	100	100	100	100

Table 16 expands the data that was summarized in the school data section in Table 2, page 8. As schools get larger, the percentage of students who say they are home-only computer users goes up, and the percentage who say they are school-only users goes down. This is particularly true in the 11th grade where a greater proportion of students in smaller schools are school-only users and a greater proportion of students in larger schools are home-only users. Twenty percent more of the students in the smaller schools report use in both locations.[xv]

Students Develop Software Capability at Home and at School

When asked about their capabilities as users of a variety of different types of software, students who reported using computers at both home and school had substantially higher capability scores than those who used computers in only one location. Table 17 uses z-scores to display the overall pattern of student computer capability. A positive z-score indicates students rated their computer capability more highly than the average student; a negative z-score indicates students rated their computer capability lower than the average student.

Table 17. Student Software Capability, by Location of Use and Grade

	8th Grade		11th Grade		
Location	Boys	Girls	Boys	Girls	All
Neither	-1.06	-.95	-.99	-.99	-1.00

Home only	.09	-.07	.14	-.15	-.01
School only	-.56	-.54	-.38	-.46	-.49
Both	.29	.16	.51	.24	.30
Total	.02	-.07	.21	-.06	.00

Note: The index score is based on reported capability on six different types of software, computed as a z-score, mean = 0, SD = 1. This table has at least 400 cases per cell.

The table shows that eleventh grade boys reported the most computer capability; 11th graders rated themselves higher than 8th graders, and boys more than girls. Of the two locations, home use was more closely associated with capability than school use. However, it was students who used computers in both locations that rated themselves highest on the software capabilities index.

Students who do not have access to computers in either location score far below average on software capability, about one full standard deviation below the mean. “School-only” users also score substantially below the mean (one-half standard deviation). However, it is not the home only users who report the most computer skills; they score about average, with males outscoring females. It is students who use computers in *both locations* who, on average, score almost one-third standard deviations above the mean.

Appendix J shows these results by school size. Among 11th graders, students in smaller schools are more likely to say they use computers in both locations. This may account for why student capability is not as strong a predictor of achievement at a schoolwide level (next section), because these schools are relatively low scoring despite having higher capability scores. In the next section, we use student software capability as a predictor of achievement, noting that computer use at both home and school seems to contribute to this student capability measure.

PART 5. STUDENT SOFTWARE CAPABILITY AND SCHOOLWIDE TEST SCORES

In this section we characterize schools based on the overall computer capability reported by their students. We then compare the gains on tests from 1999 to 2000. Because a residual gain score is used, these comparisons take into account the fact that schools with students having greater computer capability scored higher on 1999 achievement tests than schools where students had lower computer capability.

Table 18 shows that schools with students who are characterized as having high computer capability gained more on a combined measure of mathematics, reading and language arts achievement than schools where students had lower computer capability, or than the average school.

Table 18. Schoolwide Student Software Capability and Test Score Gains

Schools with students characterized as having…	Mean residual test score change	N	Effect Size
Low software capability	-.03	63	
High software capability	.09	67	.20
Total	.03	130	

Note: Effect size is computed based on the standard deviation for 1999 test score index, 0.60. This difference is not statistically significant for a sample of this size.

The effect size for schools having students with higher software capability is .20, or one-fifth a standard deviation. This places these schools, on average, at the 54th percentile, or four percentile points above the mean. The average gain score for students with lower software capability was at the 49th percentile, or 1 percentile below the mean for all schools. This difference is not statistically significant, meaning it could have been caused by chance; but it is in the same direction as our other findings.

The next section provides a more careful analysis of differences in the achievement and achievement gains of students. It addresses individual student test scores and test score gains based on their software skills relative to others within their school.

PART 6. WITHIN-SCHOOL STUDENT SOFTWARE CAPABILITY AND ACHIEVEMENT

This section shows that within their schools students who have more software capability scored higher on the 2000 tests and gained more from 1999 to 2000. Student 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 19 shows that student overall achievement within their school is related to their level of software capability. On average, 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 20 shows that students' gains on test scores are also related to their computer capability. Those characterized as higher capability gained more, on average, than others within their same school.

Table 19. 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 school. The next table addresses whether students with high software capability also gained more than others within their school, controlling for their 1999 scores.

Table 20. 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, $p < .001$.

Table 20 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. Tables 19 and 20 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.

CONCLUDING SUMMARY

We started by describing basic differences between schools, teachers and students. We then looked at differences in technology use and achievement. In each case, we paid attention to variables that seemed to have an independent effect on both technology use and achievement. These independent variables included school size, grade, subject, student prior achievement, and gender. However, given the fact that Opportunity I targeted all Idaho schools, we chose to focus on the overall impact of technology on student achievement and year-to-year achievement gains. At the same time, we acknowledge that the differences shown are not the same for all types of students and schools.

Computer use at school is more often a part of student experience in small schools than it is in large schools, probably because smaller schools have more favorable computer-student ratios; a few computers go a long way in a small school, but not in a large school. At the same time, students in smaller schools are less likely to have computers at home. Because smaller schools scored lower on ITBS/TAP tests overall, this creates an inverse relationship between school-only computer use and achievement. However, when we examine students' computer capability scores, shown to be related to both computer use at home and at school, we find that students in smaller schools have equivalent capability to students in larger schools. Using this student computer capability measure to compare test scores and test score gains, we find there is a positive relationship between student software capability 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. In fact, it appears that use at school may be related to positive gains in test scores in some cases.

Our analyses show that when we look broadly across schools, there is a positive relationship between achievement and technology use. We compared achievement based on a schoolwide teacher computer use index that included the amount of software teachers use with students, and teachers' self-reported software capability. In each case, schools with teachers who used more technology or who had higher computer skills gained more on tests from 1999 to 2000 than other schools.

We also found that schoolwide teacher technology use was a better predictor of student test score gains than computer use by teachers of specific subjects; this may be because there is substantial computer use outside the core subjects and in computer classrooms. As a result, schoolwide measures of computer use predict student achievement gains on math, language arts and reading tests better than computer use by teachers of those subjects. It appears use by math teachers may nonetheless be related to gains in math in the larger 11^{th} grade schools, but in other schools the result is in the other direction. Among the subject specific uses we examined, it appears that word processing may be more closely related to gains in language arts than Accelerated Reader.

We then compared school achievement based on the technology capability reported by students. The data indicate that school test score gains may be related to the capability of its students to use software tools. However, this pattern is more clearly shown at the individual student (within-school) level, rather than when we compared schools based on their average student computer capability. This is because students in some of the smallest schools, that tend to be lower achieving overall, have relatively high capability scores. It is more meaningful to say that within-schools, those students who have higher software capability score higher and gain more than others.

Taken together, our analyses suggest that student computer use and computer capability, as well as teacher computer use and teacher computer capability are related to school and student achievement and achievement gains from 1999 to 2000. Further research is needed to determine the extent to which these findings are really a result of the computer use itself, as opposed to other characteristics of these teachers, students, and schools.

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END NOTES

[3] We treat teacher measures as schoolwide because we do not know which teachers taught which students.

[4] It is therefore important to be clear whether one is talking about numbers (or percents) of schools as opposed to numbers (or percents) of students. One must also be cautious interpreting school and student-level findings. One may think that a large percent of very small schools represents more students than it really does. Similarly, when reading student-level analyses, one must remember that a large percent of the students come from relatively few schools.

[5] All income data come from the 1990 census and reflect mean family income for those residing in the same zip code as the school.

[6] Appendix B shows that larger schools scored higher on all three tests. Scores on each of the tests are highly correlated r > .5, so in Table 2 we created an overall achievement measure based on the mean of all three. We use the mean "standardized" z-score, so each test is weighted equally.

[7]This analysis is not shown, but a clear relationship between home computer use and achievement was found within schools in both the 8th and 11th grades and in schools of different sizes.

[8] In fact, raw gains on the language arts tests from 1999 to 2000 were not as large as gains on the test of reading and math skills; this may be due to a characteristics of the test or, if not, it may indicate that changing achievement in language arts is more difficult than in other subjects.

[vii] Standardized residual gain scores were calculated by using a regression to predict 2000 achievement test scores on the basis of 1999 scores.

[viii] Fourth grade schools and students are not included elsewhere in this report, partly because data were not available for student achievement and the technology inventories were therefore of less interest.

[ix] Ten percent of teachers overall indicated they taught vocational classes, 3.5% taught business, and 1% or less taught in other areas such as Family and Consumer Science.

[x] The survey was initially distributed in February with a follow-up mailing in April for teachers who didn't respond initially. Thus the data on Table 8 reflects software use across approximately seven months of the school year.

[xi] To represent the change in test scores in effect size terms we divide by the standard deviation for the original 1999 overall score that was used in calculating residual change. (We don't use the standard deviation for the change score, but express the change in terms of standard deviations based on the original score.) This overall 1999 score was based on the mean standardized score on all three 1999 tests and had a standard deviation of 0.6.

[xii] Residual scores are not standardized in the same way as other scores; this is why the means are not exactly equal to zero.

[xiii] For each grade we divided schools into larger and smaller schools. Because the number of cases was low, we used 50% break points of 420 8^{th} graders, and 437 11^{th} graders. This provides about 20 data points for each subject and grade combination. Each data point represents the aggregated scores of teachers in each school. For schools where we obtained only a small fraction of teachers we decided to keep cases in order to use all of the information we obtained.

[xiv] Data for English teachers and for subject-specific uses of software are available from the authors.

[xv] The reader is reminded that -- in terms of the raw number of students - a smaller percent of students in large schools still represents more students than those who attend smaller schools.

Appendix A. Data Sources and Variables

This study uses individual and schoolwide measures of student achievement based on the Iowa Test of Basic Skills and the Test of Academic Proficiency (ITBS / TAP). School level technology inventories collected by the Bureau of Technology Services, Idaho Department of Education provide data about school technology resources. A teacher survey based on Becker and Anderson (1998) was used to collect data about pedagogy and technology use.

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 also obtained data from the statewide administration of the Iowa Tests of Basic Skills (ITBS) in Language Arts, Reading, and Mathematics and the Test of Academic Proficiency (TAP). ITBS is given to 8th graders; TAP is given to 11th graders. The total number of students in the study is 31,000 from over 300 schools.

Student Self-Reported Computer Capability and Use. 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. A subset of the 17-item instrument asked specifically about capabilities to perform tasks, such as word processing, spreadsheets, presentations, Internet and email. Alpha = .75. Students were also asked to indicate (8, 4-7, 1-3, 0 hours) how much they used computers at school and at home.

Student and School Achievement. The primary outcome conceptualized for this study is student achievement and achievement gains, but this can be measured at both the school and student levels. Because administration of 2000 tests was contemporaneous with administration of the student and teacher surveys, we used the 2000 tests to represent student and school achievement. Schoolwide achievement is based on the aggregate scores for all students. If a school had 8th and 11th grades, we separated the students into different schools for our analyses.

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.

This study makes a distinction between technology use as a predictor of overall 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 better for other variables). When it seemed helpful, we reported "raw" gains (the average score in 2000 minus the average score in 1999) and standardized residual gains that take into account how much one gains relative to what would have been expected given their initial 1999 achievement level. In general, we trust analyses based on the residual gains more because a raw gain that is less than the average gain should be viewed as less of an accomplishment than it might appear. School wide gain scores on all three tests were correlated (r > .6), which means that it can be helpful to use the overall gain score to summarize patterns that are the same across different tests.

TEACHER DATA SET. To address variations in objectives and conditions for teacher technology use we developed a teacher survey. This survey used a subset of items based on a national study entitled Teaching, Learning, and Computing: 1998, and the teacher survey developed by Henry Jay "Hank" Becker at University of California, Irvine. For more information, see the Web site: http://www.crito.uci.edu/TLC.

Schoolwide Teacher Scores. Because we have no way of matching individual teachers to students, we use the teacher data to create school wide measures. Overall scores for the teachers in each school are based on an aggregate of all teachers within the school for whom we have data. If a school had 8th and 11th grades, we separated the teachers into different schools for our analyses. We address a few teacher-level questions in this report, but more in-depth analysis of teacher data and comparisons between teachers will be provided as part of a separate Teaching with Technology (TWT) evaluation that is being conducted.

Overall Teacher Technology Use Index. Using the teacher data we created the following measures: Mean number of classroom computers, teacher software use with students, importance ascribed to computer use, frequency of requiring student use, professional uses of computers, and software capability of the teacher. Each of these is detailed below. An overall index based on the mean z-score on each of these separate measures had corrected item-total correlations ranging from .46 to .58; standardized alpha = .85.

Mean Number of Classroom Computers for Student Work. Teachers who completed the survey indicated the number of computers available for student work in their classroom. The school wide mean was aggregated for each subject taught. One topic we did not address is lab computer access, although we do note that it is correlated with the teacher use measures. Although it would have improved the reliability of our index it is doubtful that it would have changed any of the results. This can be taken up as part of the Teaching with Technology (TWT) evaluation that is scheduled to be completed in Summer 2002.

Teacher Software Use with Students

Each teacher was asked to indicate the amount of use of nine different types of software that were characterized as "tool" applications. These included simulations or exploratory environments; encyclopedias and other references on CD; word processing; software for making presentations; graphics-oriented programs; spreadsheets or database programs; Hyperstudio/HyperCard or other multimedia software; world wide web browsers; electronic mail.

Additional types of software were characterized as "subject specific": Accelerated Reader, Accelerated Math, and data visualization tools including graphing calculators. Teachers also indicated how much their students used "games for practicing skills". These four uses were less well correlated with the others.

For each of these the teacher indicated whether it was used with students in "No lessons";"1-2 lessons"; "3-9 lessons"; or "10+ lessons". When all these uses were combined into a single measure, the reliability for this "overall software use with students" measure was lower than the "tool only" index which had a standardized alpha = .85.

Importance Ascribed to Computer Use. For each of the last five years we asked teachers to rate the importance of computers to their instructional practices. Teachers indicated the importance of computers in their teaching for each of the past five academic years using the scale: "Did not use computers"; "Minor importance"; "Moderately important"; and, "Very important." Using an ordinal scale, the mean importance was calculated.

Teacher Frequency of Requiring Student Computer Work. We used a single question to determine the frequency of requiring students to use computers. We specified that they answer for the class where they are "most satisfied with their teaching" and how often they required a "typical" student in that class to use computers for an assignment. The responses were "Never"; "Rarely", "Monthly (at least every few weeks)"; Weekly (at least once per week)"; and "Almost daily (3 or more days per week." Teachers were given a score based on their response with a low score of one (Never) and a high score of 5 (Almost daily).

Professional Uses of Computers by Teachers. Each teacher was asked to indicate the amount of use of nine different types of software that were characterized as "professional use" applications. These included using computers to record grades; to make handouts; to communicate with parents via email or another application; writing lesson plans; getting information from the

Internet; using camcorders; digital cameras or scanners; exchanging computer files; and posting student work or ideas on the World Wide Web.

For each of these uses the teacher indicated the frequency of their use for professional purposes. The choices were “Do not use”; Occasionally”; “Weekly”; and “More often.” When all these uses were combined into a single measure, the standardized alpha reliability for this “professional use” measure was .77.

Teacher Capability with Software. For each of the following items, teachers indicated their level of technology proficiency using the scale “Don’t know how”; “Limited: Just learning”; “Competent: Can complete satisfactorily; or “Expert, can teach others.” The items included: “Display the directory of a disk”; Copy files from one disk to another”; “Create a new database and layouts”; Create a word processor document with graphics”; “Create a spreadsheet that calculates grades”; Prepare a slide show using presentation software”; “Use a World Wide Web search engine”; “Create a web page”; “Troubleshoot network problems”; “Develop a multimedia presentation”; and, “Attach files to an email message.”

The reliability of the index constructed using the average of these items is the strongest of the technology-related measures, standardized alpha = .92.

APPENDIX B. LARGER SCHOOLS SCORED HIGHER ON ALL THREE TESTS

Table 2, page 8 showed how overall test scores varied by school size, using a combined index. Here we show that the pattern is consistent in both grades and for all three tests.

			Raw Scores			Within Grade Z-scores			
Grade	Number of Students	N	Math	Lang Arts	Reading	Reading	Lang Arts	Math	Overall (all 3 tests)
8	< 150	33	241	232	241	-0.39	-0.61	-0.42	-0.48
	150-349	57	247	243	246	0.01	0.06	0.03	0.03
	350-799	45	249	245	248	0.15	0.22	0.19	0.19
	800-1249	12	250	251	252	0.47	0.59	0.28	0.44
	Total	147	246	242	246	0	0	0	0
	Sd (8th)		13	16	12	1	1	1	1
11	< 150	37	261	250	264	-0.60	-0.95	-0.81	-0.79
	150-349	55	272	266	272	-0.01	0.07	-0.03	0.01
	350-799	31	279	271	275	0.23	0.36	0.45	0.35
	800-1249	19	281	274	279	0.50	0.58	0.56	0.55
	1250+	11	282	278	280	0.59	0.81	0.62	0.67
	Total	153	273	265	272	0	0	0	0
	SD (11th)		15	16	13	1	1	1	1
Total	< 150	70	251	242	253	-0.50	-0.79	-0.63	-0.64

150-349	112	259	254	259	0.00	0.06	0.00	0.02
350-799	76	261	256	259	0.18	0.28	0.30	0.25
800-1249	31	269	265	268	0.49	0.58	0.45	0.51
1250+	11	282	278	280	0.59	0.81	0.62	0.67
Total	300	260	254	259	0	0	0	0
SD (all)		19	20	18	1	1	1	1

Note: This table 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. The z-scores have a mean of zero and a standard deviation of one and were calculated separately for each grade.

APPENDIX C. SCHOOL WIDE RAW GAIN SCORES, BY GRADE AND SIZE

		School Wide Raw Gain in…			
Grade	Number of students in school	Language Arts	Math	Reading	Number of schools
8th (N=148)	< 150	7.28	14.98	13.36	34
	150-349	7.72	13.65	12.05	57
	350-799	6.19	12.21	11.65	45
	800-1249	6.01	1.82	1.83	12
	All 8th grades	7.01	13.28	12.13	148
	S.d.	7.30	6.86	6.66	
11th (N=147)	< 150	-.01	1.19	2.87	34
	150-349	.20	3.63	5.43	52
	350-799	-.68	5.73	5.24	31
	800-1249	-2.07	4.55	3.52	19
	1250+	5.05	9.20	6.89	11
	All 11th grades	.04	4.04	4.66	147
	S.d.	14.04	11.25	9.92	

Note: This table shows average gains for each school size category based on the aggregate student gains for each school.

APPENDIX D. DIFFERENCES IN SUBJECTS TAUGHT, BY GENDER AND GRADE

	Male		Female		
Subject Taught	8th (N=173)	11th (N=374)	8th (N=243)	11th (N=282)	Total (N=1072)
English-Language Arts-Reading	9%	10%	34%	31%	21%
Science	19	16	13	7	14

Math	21	18	20	21	20
Social studies	22	17	12	8	15
Vocational-Business-Other	19	34	12	28	25
Computers/Technology	9	5	8	5	6
Totals	100	100	100	100	100

Note: We do not have subject taught information from 4th grade teachers.

APPENDIX E. TEACHER INTEREST IN TECHNOLOGY TRAINING TOPICS, BY GRADE

4th grade	None	Start from scratch	Just a refresher	Advanced course	Total
Creating multimedia...	12%	30%	32%	25%	100%
Managing students and activities…	12	24	34	30	100
Integrate technology daily...	13	18	35	33	100
Digital imaging...	13	24	38	25	100
Presentations software...	21	20	36	23	100
Using the WWW as an instructional resource...	27	13	32	28	100
Databases...	15	26	46	13	100
Spreadsheets...	17	16	49	18	100
Word processing...	53	2	21	25	100
Basic PC operations...	42	2	44	12	100
8th grade					
Digital imaging...	15	29	28	27	100
Creating multimedia...	14	28	31	27	100
Managing students and activities…	17	27	30	26	100
Integrate technology daily...	17	22	31	31	100
Databases...	20	27	37	16	100
Presentations software...	26	16	33	24	100
Using the WWW as an instructional resource...	29	12	34	25	100
Spreadsheets...	28	14	39	19	100
Word processing...	55	2	23	21	100
Basic PC operations...	53	4	31	12	100
11th grade					
Creating multimedia...	20	30	25	26	100
Integrate technology daily...	19	16	29	36	100
Digital imaging...	18	28	30	24	100
Managing students and activities…	21	22	28	29	100
Databases...	22	21	37	21	100

Presentations software...	29	14	32	25	100
Using the WWW as an instructional resource...	29	9	34	28	100
Spreadsheets...	33	11	35	21	100
Word processing...	55	2	22	22	100
Basic PC operations...	57	2	28	13	100

APPENDIX F. PERCENTAGE OF TEACHERS REQUIRING STUDENT COMPUTER USE, BY GRADE AND SUBJECT TAUGHT

		How often a typical student is required to use computers for one of your assignments…			
Subject taught	Grade	Never or Rarely	Monthly	Weekly or Almost Daily	Total
English-Lang Arts-Reading	8	22%	35%	43%	100%
	11	11	43	47	100
Science	8	40	43	17	100
	11	31	43	26	100
Math	8	72	11	18	100
	11	70	11	19	100
Social studies	8	31	53	17	100
	11	33	39	29	100
Voc-Business-Other	8	41	17	42	100
	11	14	26	60	100
All Subjects	8	37	30	33	100
	11	29	29	43	100

APPENDIX G. PERCENTAGE OF TEACHERS USING SOFTWARE WITH STUDENTS THREE OR MORE TIMES, BY SUBJECT AND GRADE

	Word Processing		World Wide Web		CD-ROM, encyclopedia		Data tools and graphing calculators		Simulations		P
	8th	11th	8th	11th	8th	11th	8th	11th	8th	11th	
English-Language Arts-Reading	81%	93%	58%	78%	48%	60%	6%	5%	10%	7%	
Science	61	60	58	57	45	39	29	44	36	41	
Math	14	10	18	16	8	9	39	82	15	26	
Social studies	75	83	68	67	56	59	17	7	15	17	
Vocational-Business-Other	53	76	52	64	34	30	16	30	33	48	

Computers-Technology	97	91	66	70	31	36	44	36	46	66
Total	60	66	51	57	37	37	23	34	22	32

	Games for practicing skills		Graphics-oriented programs		Spreadsheet/ Databases		HyperCard/ Hyperstudio		Email	
	8th	11th	8th	11th	8th	11th	8th	11th	8th	11th
English-Language Arts-Reading	16%	7%	15%	20%	2%	4%	4%	9%	13%	19%
Science	20	14	12	15	14	29	6	5	8	17
Math	24	13	4	6	13	17	2	1	7	5
Social studies	19	11	18	17	6	8	7	9	6	17
Vocational-Business-Other	26	20	27	33	12	33	10	15	5	23
Computers-Technology	43	27	49	67	54	76	29	48	31	39
Total	22	14	17	22	13	23	8	10	10	18

APPENDIX J. MATH SCORES AND GAINS BY SCHOOL SIZE, GRADE AND OVERALL TECHNOLOGY USE BY MATH TEACHER

				Means			Std. Deviations		
Grade	Size	Computer use by math teachers	N	Fall 2000 Math Score	Raw Gain	Residual Gain (within grade)	Fall 2000 Math Score	Raw Gain	Residual Gain (within grade)
8	Smaller	Low Tech	9	249.50	14.83	**0.29**	8.58	3.11	0.43
		High Tech	14	244.54	10.43	**-0.39**	10.68	5.46	0.84
		Total	23	246.48	12.15	-0.13	10.02	5.09	0.77
	Larger	Low Tech	15	249.14	12.01	-0.09	5.12	3.24	0.45
		High Tech	10	248.18	12.34	-0.07	6.83	1.24	0.17
		Total	25	248.76	12.14	-0.08	5.75	2.60	0.36
	Total	Low Tech	24	249.27	13.06	0.05	6.45	3.42	0.47
		High Tech	24	246.06	11.23	-0.26	9.28	4.29	0.66
		Total	48	247.67	12.15	-0.10	8.07	3.95	0.59
11	Smaller	Low Tech	17	277.82	3.38	0.12	11.55	7.43	0.70

		High Tech	12	274.48	2.61	0.00	9.09	8.75	0.68
		Total	29	276.44	3.05	0.07	10.56	7.87	0.68
	Larger	Low Tech	11	276.32	3.95	**0.14**	7.08	2.74	0.32
		High Tech	16	280.90	7.24	**0.47**	6.85	6.89	0.52
		Total	27	279.04	5.90	0.34	7.18	5.74	0.47
	Total	Low Tech	28	277.23	3.61	0.13	9.91	5.90	0.57
		High Tech	28	278.15	5.26	0.27	8.38	7.94	0.63
		Total	56	277.69	4.45	0.20	9.10	7.00	0.60
Total	Smaller	Low Tech	26	268.02	7.50	**0.18**	17.26	8.32	0.61
		High Tech	26	258.36	6.82	**-0.21**	18.09	8.06	0.78
		Total	52	263.19	7.16	-0.02	18.17	8.11	0.72
	Larger	Low Tech	26	260.64	8.60	**0.01**	14.91	5.04	0.41
		High Tech	26	268.32	9.20	**0.26**	17.56	5.95	0.49
		Total	52	264.48	8.90	0.14	16.59	5.47	0.47
	Total	Low Tech	52	264.33	8.06	0.09	16.40	6.80	0.52
		High Tech	52	263.34	8.01	0.03	18.36	7.12	0.69
		Total	104	263.83	8.04	0.06	17.33	6.93	0.61

Note: Differences mentioned in the text are highlighted. Computation of effect sizes (not shown) would be based on Fall 1999 standard deviations, which are approximately the same as the Fall 2000 standard deviations.

APPENDIX J. MATH SCORES AND GAINS BY SCHOOL SIZE, GRADE AND OVERALL TECHNOLOGY USE BY MATH TEACHER

				Means			Std. Deviations		
Grade	Size	Computer use by math teachers	N	Fall 2000 Math Score	Raw Gain	Residual Gain (within grade)	Fall 2000 Math Score	Raw Gain	Residual Gain (within grade)
8	Smaller	Low Tech	9	249.50	14.83	**0.29**	8.58	3.11	0.43
		High Tech	14	244.54	10.43	**-0.39**	10.68	5.46	0.84
		Total	23	246.48	12.15	-0.13	10.02	5.09	0.77
	Larger	Low Tech	15	249.14	12.01	-0.09	5.12	3.24	0.45
		High Tech	10	248.18	12.34	-0.07	6.83	1.24	0.17
		Total	25	248.76	12.14	-0.08	5.75	2.60	0.36
	Total	Low Tech	24	249.27	13.06	0.05	6.45	3.42	0.47
		High Tech	24	246.06	11.23	-0.26	9.28	4.29	0.66
		Total	48	247.67	12.15	-0.10	8.07	3.95	0.59
11	Smaller	Low Tech	17	277.82	3.38	0.12	11.55	7.43	0.70
		High Tech	12	274.48	2.61	0.00	9.09	8.75	0.68
		Total	29	276.44	3.05	0.07	10.56	7.87	0.68
	Larger	Low Tech	11	276.32	3.95	**0.14**	7.08	2.74	0.32
		High Tech	16	280.90	7.24	**0.47**	6.85	6.89	0.52
		Total	27	279.04	5.90	0.34	7.18	5.74	0.47
	Total	Low Tech	28	277.23	3.61	0.13	9.91	5.90	0.57
		High Tech	28	278.15	5.26	0.27	8.38	7.94	0.63

		Total	56	277.69	4.45	0.20	9.10	7.00	0.60
Total	Smaller	Low Tech	26	268.02	7.50	**0.18**	17.26	8.32	0.61
		High Tech	26	258.36	6.82	**-0.21**	18.09	8.06	0.78
		Total	52	263.19	7.16	-0.02	18.17	8.11	0.72
	Larger	Low Tech	26	260.64	8.60	**0.01**	14.91	5.04	0.41
		High Tech	26	268.32	9.20	**0.26**	17.56	5.95	0.49
		Total	52	264.48	8.90	0.14	16.59	5.47	0.47
	Total	Low Tech	52	264.33	8.06	0.09	16.40	6.80	0.52
		High Tech	52	263.34	8.01	0.03	18.36	7.12	0.69
		Total	104	263.83	8.04	0.06	17.33	6.93	0.61

Note: Differences mentioned in the text are highlighted. Computation of effect sizes (not shown) would be based on Fall 1999 standard deviations, which are approximately the same as the Fall 2000 standard deviations.

APPENDIX K. STUDENT SELF-RATED SOFTWARE CAPABILITY, BY LOCATION OF USE AND SCHOOL SIZE

Grade	Location of Use	N*	Size of School < 150	150-349	350-799	800-1249	1250+	Total
8	Neither	41	-0.86	-1.02	-1.06	-0.93		-1.01
	Home only	81	-0.18	-0.02	0.00	0.02		0.00
	School only	88	-0.50	-0.43	-0.63	-0.49		-0.55
	Both	236	0.22	0.21	0.21	0.30		0.23
	Total	446	-0.09	-0.02	-0.05	0.02		-0.03
11	Neither	18	-0.43	-0.99	-0.97	-0.99	-1.05	-0.99
	Home only	39	0.03	-0.33	-0.06	0.02	0.02	-0.01
	School only	69	-0.34	-0.42	-0.39	-0.39	-0.55	-0.42
	Both	211	0.46	0.31	0.37	0.45	0.33	0.38
	Total	337	0.20	0.03	0.07	0.13	0.03	0.08
Total	Neither	59	-0.73	-1.01	-1.04	-0.96	-1.05	-1.00
	Home only	120	-0.11	-0.12	-0.01	0.02	0.02	-0.01
	School only	157	-0.43	-0.43	-0.56	-0.43	-0.55	-0.49
	Both	447	0.33	0.25	0.25	0.39	0.33	0.30
	Total	783	0.03	0.00	-0.01	0.08	0.03	0.02

* The lowest number of cases for each row is shown.

Note: The capability index is based on six different items, asking students how proficient they were with different software tools, like word processing. 11th grade students in the smallest schools report the highest levels of computer capability. This is somewhat surprising, as we might expect home users who go to larger schools to have more skills. At least in 11th grade, substantial tool use may be occurring in these smaller schools.