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Who's Wired and Who's Not: Children's Access to and Use of Computer Technology

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Abstract

As computer technology becomes increasingly prevalent throughout society, concerns have been raised about an emerging "digital divide" between those children who are benefitting and those who are being left behind. This article presents results from new analyses of national survey data describing children's differential access to computers in school and at home, and the varying conditions that affect how children experience computers. For example, responses from a nationwide survey of teachers suggest that, as of 1998, more than 75% of students had access to computers at school. In fact, those teaching lower-income students reported weekly use of computers more often than those teaching higher-income students. But the nature of children's experiences using computers in school varied greatly by subject and teacher objectives, and the data suggest that lower-income students use computers more often for repetitive practice, whereas higher-income students use computers more often for more sophisticated, intellectually complex applications.

Differences between low-income and high-income children's access to home computers were far less subtle. Survey data indicate that only about 22% of children in families with annual incomes of less than $20,000 had access to a home computer, compared to 91% of those in families with annual incomes of more than $75,000. And among children with access, those in low-income families were reported to use the computer less than those in high-income families, perhaps because most low-income families with computers lacked a connection to the Internet. The two most predictive factors of children's use of home computers were the child's age and the computer's capabilities. The author concludes that home access to computers will be a continued area of inequality in American society, and that schools must play a critical role in ensuring equal opportunity for less-advantaged children to access the benefits of the more intellectually powerful uses of computer technology.

In nearly every American city, town, and neighborhood, the personal computer and its electronic offspring have affected young people's lives. This new Net generation is evidenced in adolescents playing computer games or surfing the Web, in young children learning abstractions through

playful computer-centered environments, in precocious hackers busily investigating and modifying the performance of software, in preteens partaking in online chats and electronic mail, and in the many young people expressing themselves with the help of writing and graphic arts software tools. Yet other children and adolescents in these same communities have hardly been affected by computer technology. Just as a great many young people have been transformed by the electronic culture, others—whether due to lack of interest, lack of understanding, or lack of opportunity—seem barely touched.

Such differences have raised concerns about the emergence of a "digital divide" between the children on one side who are benefitting from computer technology and the children on the other side who are being left behind. This article examines the extent of children's access to computers in schools and at home and describes general patterns of computer technology presence and use in both settings. Most of the data concerning school computers presented in this article are from original analyses of responses to a national survey of more than 4,000 teachers, *Teaching, Learning and Computing: 1998—A National Survey of Schools and Teachers* (TLC-1998).[1] The primary data source for children's home computer use is the U.S. Census Bureau's Current Population Survey of U.S. Households (CPS), 1997 and 1998 supplements, which gathered information on home computer and Internet access from parents about more than 23,000 children. Although a few years old, these surveys remain valuable because of their size and comprehensiveness.[2] Data from all three surveys were analyzed to examine how demographic factors relate to opportunities to use computers, and how computer use is affected by conditions in schools and at home—such as teacher objectives for student computer use and the technology-related experiences of family members. Finally, key conclusions and interpretations are offered in the hopes of guiding efforts to shrink the digital divide and to ensure equal access to the effective use of computers for all of America's children.

School Computers and How They Are Used

Next to families, schools are the institutions most responsible for instilling in children the knowledge and skills believed to lead to productive lives and cultural continuity. Schools play a critical role in ensuring equal opportunity for less-advantaged children by providing access to a wide range of enriching experiences, including exposure to computer technology. Indeed, for many children, school provides the greatest opportunity to use computers. According to parents' estimates from the CPS 1997 supplement, more than half of school-age children use computers at school several times per week—nearly twice the number of chil-

dren who use computers that often at home (see Figure 1).

Nevertheless, schools must struggle to keep up with the rapid pace of technological and cultural change. Survey data indicate that, although classroom access to computers is increasing rapidly, the most frequent and creative uses of computer technology are not yet linked to curricula, and many factors influence the use of computers in schools. Substantial progress is needed if schools are to play an effective role in ensuring equal opportunity for less-advantaged children to access and use computers.

Access to School Computers

Since the early 1980s, the number of computers in American schools has increased steadily, from only 250,000 in 1983 to 8.6 million in 1998 (see Figure 2). In 1983, almost half of the nation's schools had no computers at all; by 1998, all schools were equipped with at least one computer, as were nearly half of all classrooms. The typical school in 1985 averaged 40 students for each computer; by 1998, this average had shrunk to 6 or 7 students per computer.[3] These numbers indicate that students' access to school computers has increased significantly. For computers to become an integral tool for learning, however, further improvements are needed in both the quantity and quality of computers available in classrooms.

Only about 1 in 10 secondary teachers of core academic classes could be considered an active user of analytic or product-oriented software in their teaching.

One obstacle to effective computer use is outdated technology. As schools have been building their computer inventories, technology has been developing at a rapid pace. For many years, while commercial, university, and home users were migrating to new, more sophisticated models, schools seemed to be increasingly saddled with outdated, stand-alone computers. As of 1992, only 22% of school computers were considered contemporary for the period.[3] A 1997 White House Panel on Educational Technology concluded that a large share of the school computer inventory was "obsolete and of very limited utility."[4] In the mid-1990s, however, schools began to replace their older machines. By 1998, some 45% of school computers were models such as Pentiums or Power Macintoshes, which were introduced within the previous five years.[3] In addition, access to the newest mass-market computer technology—the Internet and the World Wide Web—spread rapidly among schools. The percentage of instructional rooms with one or more Internet connections increased from only 3% in 1994 to 63% in 1999.[5]

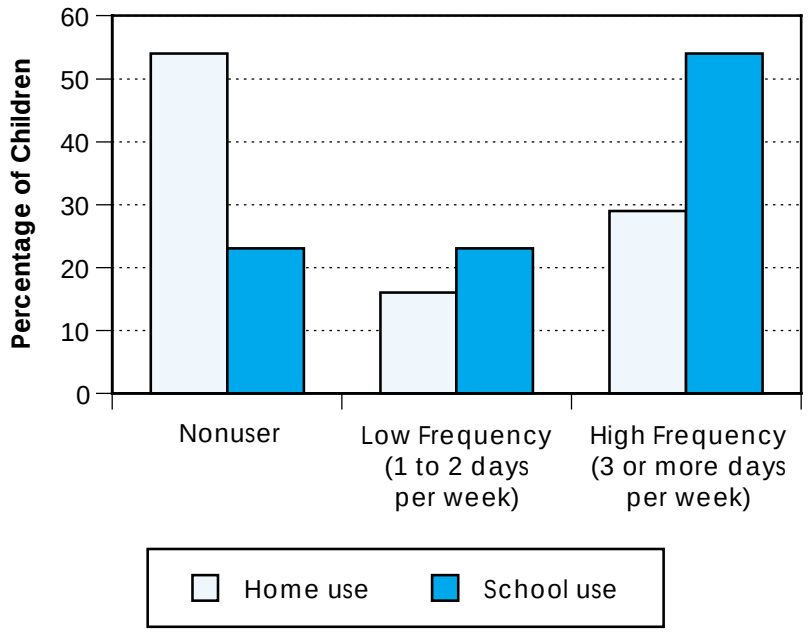
Despite this flurry of technology infrastructure-building, most schools could not yet be described as well-equipped because they did not permit routine integration of computer technology into the learning activities of most classes. As an indication of how well-equipped schools are nationwide, data from the national survey, TLC-1998, were analyzed based on eight benchmarks related to the density and type of computer technologies available in schools (see Table 1). A majority of schools surveyed met only one of the eight benchmarks: connection of at least 50% of their computers to a local area network. Averaged across all school levels, only 15% met five or more benchmarks overall. In general, middle and high schools were more likely to meet the benchmarks than were elementary schools.

The analysis of TLC-1998 data also found differences in computer access based on a school's socioeconomic status (SES). These differences were not reflected in numbers of computers so much as in type of Internet access. Across all SES groups, schools were about equally likely to have at least one computer per four students; however, significant differences were found with respect to connections to the Internet. As of 1998, low-SES schools were only about half as likely as high-SES schools to have high-speed Internet access, to have at least one computer with Internet access for every 12 students, or to have half of their classrooms connected to the Internet.[6]

Although few schools at any SES level were meeting most of these benchmarks in 1998, an increasing number of schools are

Figure 1

Children's Use of Computers in School and at Home in 1997



Sources: Data analyzed from the U.S. Census Bureau's Current Population Survey of U.S. Households, October 1997 supplement. For a more detailed analysis of these data, see Becker, H.J. Who's wired and who's not. *Teaching, learning and computing: 1998—A national survey of schools and teachers.* Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, 2000. Available online at http://www.crito.uci.edu/TLC.

meeting more of the benchmarks each year. Thus, the disadvantages between high-SES and low-SES schools can be thought of in terms of the number of years required for lower-SES schools to meet the same benchmarks as the higher-SES schools. From this perspective, schools with the most students from low-income families are about one to two years behind schools with students primarily from average-income families, and another one to two years behind schools with students mostly from high-income families.

Across all SES levels, several more years of progress will be required before most schools acquire a sufficient Internet-connected computer infrastructure to enable technology to become an integral learning tool in most classrooms. Meanwhile, what is considered an essential technological infrastructure is constantly changing, so that just as schools meet one set of benchmarks, new ones emerge. As a result, most schools will continue to be technologically challenged well into the future.

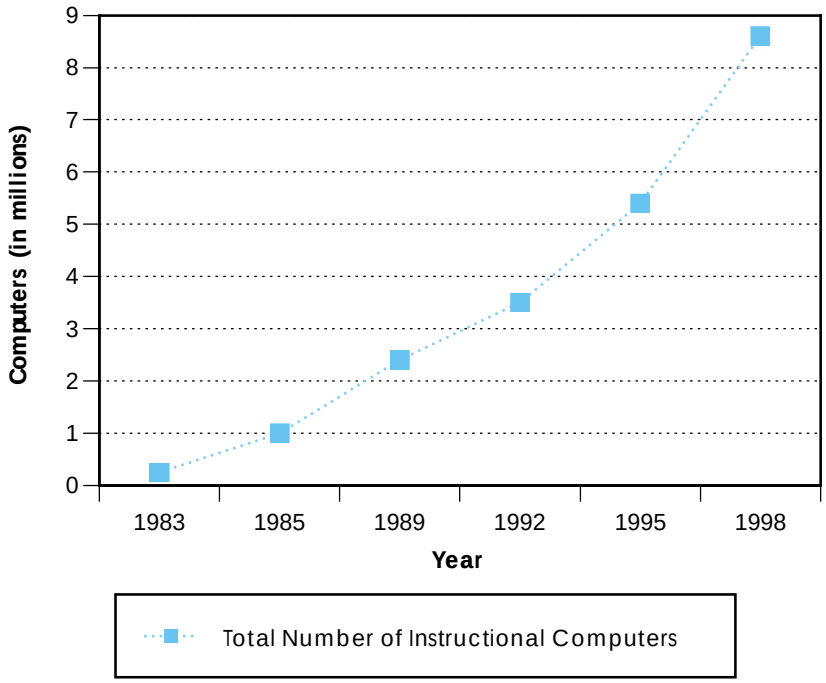
Most Frequent and Creative Uses Not Yet Linked to Curricula

Because schools are so large and composed of so many discrete parts, the amount of technology present in a school building gives only a rough indication of its likely impact on individual students. The same number of computers may be spread among classrooms or concentrated in a computer lab. A computer with Internet access may be in the library or in the principal's office. A better indicator of students' exposure to technology is the fraction of students with frequent access to current hardware and software in their different classes. According to the TLC-1998 national survey of teachers, the most frequent and creative uses of computers are found in computer classes and other specialized classes, rather than in core academic classes such as English, science, math, and social studies.

Over the course of a school year, most students are exposed to substantial computer experience in at least one of their courses. Data from the TLC-1998 survey indi-

Figure 2

Number of Instructional Computers in U.S. Schools, 1983 to 1998



Source: Anderson, R., and Ronnkvist, A. The presence of computers in American schools. *Teaching, learning and computing: 1998—A national survey of schools and teachers, report #2.* Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, and University of Minnesota, June 1999. Available online at http://www.crito.uci.edu/tlc/html/findings.html.

cate that, on average, at least one or two of the classes students take each year in middle and high school are "frequent computer-use classes"—that is, classes in which students use computers more than 20 times per year.[7] Besides computer classes, in which computers are the subject matter, high school and middle school classes most likely to use computers frequently are in applied areas such as business and vocational education.[8] Among core academic subjects, English teachers are more likely than others to use computers frequently during class time (see Figure 3). In the TLC-1998 sample, high school students were most likely to use computers in core academic subjects when participating in specialized classes that allow more curricular flexibility, such as those designed specifically for honors students or for students bridging vocational and academic work. Aside from such specialized classes, most core academic courses provided limited opportunity to use computers.

Interestingly, teachers in economically disadvantaged schools are as likely to report that their students use computers on a weekly basis as are teachers in more advantaged schools. In fact, among teachers in three of the four main academic subjects covered in the TLC-1998 survey, those working in low-SES schools reported more frequent computer use than did teachers from any other SES group (see Figure 4).[9] Only in science did teachers from the top SES group of schools report more frequent weekly computer use by students than teachers from the lowest SES group, and even for that subject, the difference was small. Whether this exposure to computer technology is enhancing learning in the same way across the various SES levels, however, depends on how teachers have their students use computers.

In addition to frequency of use, the nature of use—as indicated by the type of software or application—is an important

Table 1

Technology Access by School Level, 1997-98

Benchmark	Elementary School	Middle School	High School	All Schools
At least 50% of computers connected to a local area network (LAN)	50%	64%	63%	55%
At least 1 computer for every 4 students	10%	29%	33%	18%
At least 1 Pentium/Power Mac for every 6 students	7%	14%	14%	10%
At least 1 CD-ROM-equipped computer for every 6 students	11%	27%	17%	15%
At least 50% of rooms with high-speed Internet access	16%	17%	22%	17%
At least 50% of rooms connected to LAN	34%	46%	30%	35%
High-speed Internet access somewhere at school	24%	35%	45%	30%
At least 1 Internet-accessible computer for every 12 students	24%	39%	41%	30%
Met at least 5 of the 8 benchmarks	12%	21%	23%	15%

Source: Data analyzed from *Teaching, learning and computing: 1998—A national survey of schools and teachers.* Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, 1998. See the project's home page at http://www.crito.uci.edu/TLC.

consideration in determining how the presence of computers in schools might affect student learning. A wide range of software is now available—from word processing and information retrieval applications to more sophisticated analytic programs for understanding patterns in data, developing spreadsheet models, creating presentations, and constructing interactive multimedia environments. Although an increasing number of teachers are beginning to incorporate computer use into the curricula, data from the TLC-1998 survey indicate that children's opportunities to experience the more analytic and creative software programs are still most likely found in computer classes, rather than linked to course work in core academic subjects.[10]

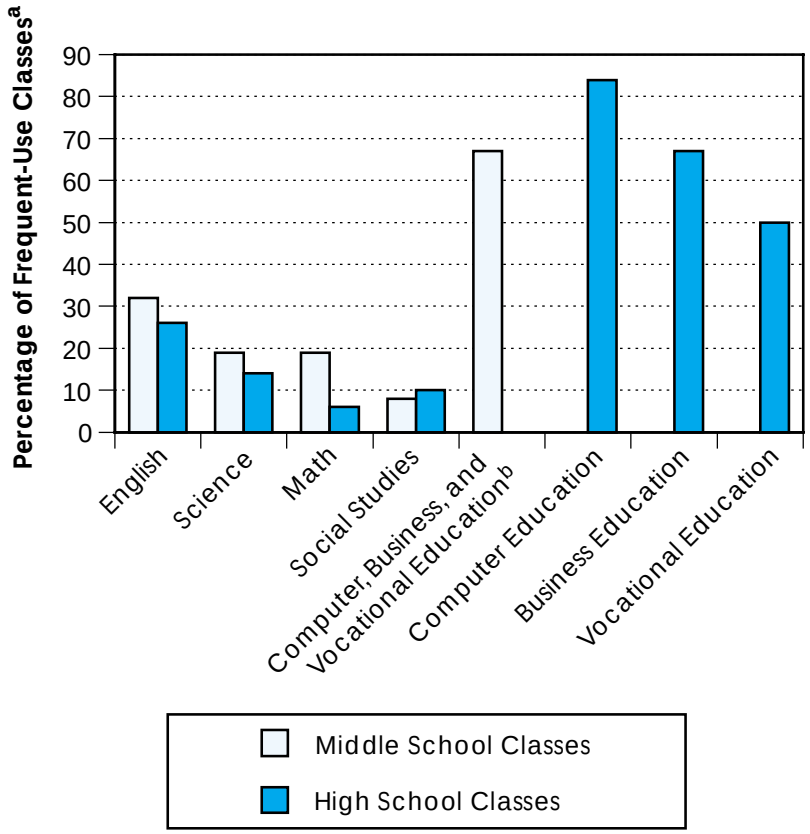
Even in academic classes, however, current use of software involves more complex computer applications than the basic skill games and computer literacy activities that previously dominated classroom computer use. For example, word processing is the most common computer activity for students in academic classes. By 1998, not only English, but also science, social studies, and elementary school teachers were more likely to have their students use the computer for word processing than any other type of activity. In the TLC-1998 survey, 60% of all English teachers, and about 40% of both science and social studies teachers, had their students use computers for word processing during class time (see Table 2).[11] Among those who made word processing assignments, most made such assignments quite frequently—at least 10 times during the year.

After word processing, the next most common computer activity linked to the curriculum is information acquisition—that is, using CD-ROM reference titles and Web search tools for research. Elementary schoolchildren tend to use the more controlled information bases such as encyclopedias on CD-ROMs, whereas secondary school students tend to use the Web at least as often as CD-ROMs in subjects such as English, social studies, and, most intensively, science. By 1998, only four years after its initial public distribution, teachers were assigning students work involving use of World Wide Web browser software more often than any other type of software except word processors and CD-ROMs.[12] However, the greatest use of the Web by far was in computer education classes.

In addition to word processing and information retrieval, many other computer applications using analytic or product-oriented software could be linked to academic use, but survey results indicate that they are used much less often. For example, some science classes use analytic software such as a "simulation modeling program" to study ecological systems, which enables students to explore how different factors in a particular situation lead to a stable population or to dis-

Figure 3

Frequent-Use Classes in Middle and High School, by Subject, 1997-98



[a] Frequent-use class is defined as a class in which students used computers more than 20 times during the school year.

[b] Separate figures for these classes were not available at the middle school level.

Source: Adapted from data in Becker, H.J., Ravitz, J.L., and Wong, Y.T. Teaching and teacher-directed student use of computers and software. *Teaching, learning and computing: 1998—A national survey of schools and teachers, report #3.* Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, and University of Minnesota, revised December 1999, p. 7. Available online at http:www.crito.uci.edu/tlc/html/findings.html.

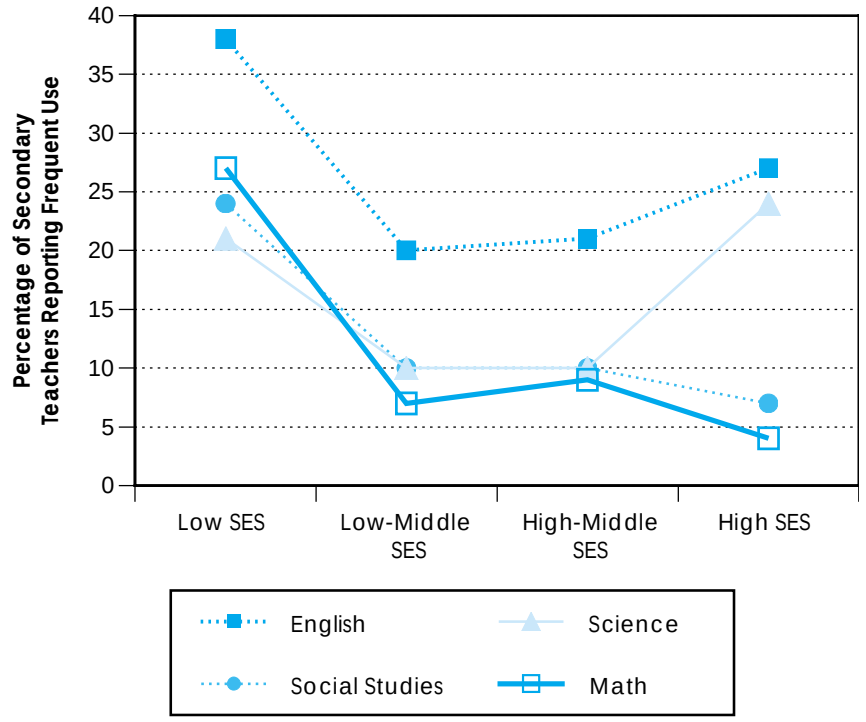
equilibrium of various species. Some math classes use spreadsheet programs to explore numerical relationships to help students gain intuitive appreciation for mathematical equations. (See the article by Roschelle and colleagues in this journal issue for more detailed descriptions of these applications.) Relatively few teachers have adopted such approaches in their curricula, however.

Overall, the TLC-1998 data indicate that only 22% of science teachers and 12% of social studies teachers had their students use simulation software even occasionally, and only 13% of math classes used spreadsheets more than once or twice during the year. Of course, students' use of electronic technologies such as graphing calculators is quite high in many math classes. But the data show that using general-purpose computers for more sophisticated applications—such as spreadsheet calculations, analysis of large amounts of "real data," or library research into real-world applications of quantitative procedures—has not yet become part of the curricula in most middle and high school mathematics classrooms.

Similarly, product-oriented software—such as that used for creating presentations

Figure 4

Frequent Computer Use in Academic Subjects, by School-Level Socioeconomic Status Quartile, 1997-98



Note: Frequent computer use was defined as students using computers more than 20 times during the school year. School-level socioeconomic status (SES) quartiles were determined by a factor score that incorporates data on school eligibility for subsidies under the Education for the Disadvantaged program (also known as Chapter 1), principals' assessments of parents' type of employment and the percentage of students with limited proficiency in English, and an index characterizing the SES of the neighborhood where the school is located. All schools were then arrayed based on these scores and divided into four comparably sized groups from "low" to "high" SES.

Source: Data analyzed from *Teaching, learning and computing: 1998—A national survey of schools and teachers*. Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, 1998. Available online at http://www.crito.uci.edu/TLC.

and multimedia projects—could be linked to academic curricula in situations where teachers have students communicate their understanding of content by demonstrating their work. Applications are available for making and printing brochures, designing presentations for a live audience, or creating multimedia projects incorporating related text, pictures, video, music, voiced commentary, and even puzzles or games. In particular, the interactive, "nonlinear" structure of multimedia projects engages class interest by providing group decision points for exploring alternative aspects of the topic. Although increasing numbers of teachers have students prepare computer-assisted presentations and multimedia documents, the numbers are still small in every subject and level. Only 11% of English teachers in the TLC-1998 survey had students use relatively simple presentation software, and only 11% of social studies teachers and 8% of science teachers had students even occasionally use multimedia authoring.

As shown in Table 2, it is mostly in elective classes—such as computer, business, and vocational education—that students are provided opportunities to explore the newer, more sophisticated and creative, analytic, and product-oriented software.[13] The data suggest that only about 1 in 10 secondary

Table 2

Percentage of Teachers Using Software in Three or More Lessons, by Subject, 1997-98

	Early Software Applications		Information Retrieval		Analytic Software		Product-Oriented and Communication Software			
	Skill Practice Games	Word Processing	CD-ROM	World Wide Web	Simulations/ Exploratory Environments	Spread-Sheets/ Database	Graphics Printing	Presentation	Multi-media Authoring	Student E-mail
Elementary School Classes (Grades 4+)	**62%**	**66%**	**54%**	26%	32%	10%	27%	8%	13%	7%
Secondary School Classes										
Core academic classes										
English	18%	**60%**	42%	34%	12%	8%	17%	11%	7%	6%
Science	11%	**41%**	36%	**35%**	22%	17%	16%	**8%**	8%	8%
Math	**25%**	15%	9%	16%	18%	13%	8%	6%	4%	2%
Social Studies	14%	**38%**	33%	31%	12%	11%	12%	16%	**11%**	**9%**
Specialized classes										
Computer Education	**35%**	**87%**	33%	**48%**	48%	**66%**	55%	**45%**	**22%**	**16%**
Business Education	**23%**	**86%**	22%	37%	**32%**	**63%**	**40%**	**34%**	5%	13%
Vocational Education	16%	41%	30%	35%	**41%**	24%	37%	23%	11%	13%
Fine Arts	3%	22%	9%	20%	12%	8%	**28%**	12%	7%	8%
Foreign Language	**16%**	32%	17%	32%	5%	**9%**	13%	2%	8%	3%
All classes	28%	**50%**	36%	29%	23%	16%	21%	12%	9%	7%

Note: Bolded blue percentages indicate that a majority of teachers who used that software did so frequently; that is, in more than 10 lessons during the year. Thus, even though only 11% of social studies teachers had students use multimedia authoring software, a majority of that group did so frequently.

Source: Data analyzed from *Teaching, learning and computing: 1998—A national survey of schools and teachers.* Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, 1998. See the project's home page at http://www.crito.uci.edu/TLC.

teachers of core academic classes could be considered an active user of analytic or product-oriented software in their teaching. Thus, although most students use a computer frequently in at least one of their classes, most often such exposure is not in an academic subject and does not involve the more sophisticated or creative software applications. Expanded use of the more complex and intellectually powerful applications has many challenges to overcome before becoming integral learning tools linked with academic curricula.[14]

Factors Affecting Use of School Computers

Students' opportunities to use computers vary according to the subjects they take, and also within the same subject. Survey data point to six important factors affecting how students experience computers in school: (1) availability of computers in the classroom, (2) teacher computer expertise, (3) teacher philosophy and objectives for computer use, (4) teacher collaboration and leadership, (5) teacher judgments of class ability, and (6) school SES level.

Availability of Computers in the Classroom

How frequently a student uses computers at school, and for what, depends greatly on how many computers are available and whether they are located within the classroom or elsewhere. Especially in high school academic classrooms—with their extensive curricular demands and 50-minute period structure—a shortage of individual computer stations in the classroom has long restricted more frequent, systematic, and well-integrated use of technology. The TLC-1998 survey found that only 14% of English teachers, 12% of math teachers, 7% of science teachers, and 2% of social studies teachers taught in classrooms with a ratio of at least one computer for every four students enrolled.[15]

Further analysis of the TLC-1998 data indicated that, among teachers of the same subject, frequent computer use is closely associated with having computers accessible in their own classroom. For example, among science and social studies teachers who assigned computer work, 53% of those with at least one computer in the classroom for every four students assigned computer work frequently, compared with 21% of those limited to access in a computer lab. Differences were found to be just as dramatic for math teachers. Across all secondary school academic classes, students with five to eight computers in their own classroom were more than twice as likely to use computers frequently during class time compared with students using computer labs—even though the labs had more than three times as many computers.[16]

Accessibility in the classroom also influences the type of software used. Science and math teachers with at least five computers in the classroom were much more likely to have their students use spreadsheet or database programs on a regular basis than were teachers whose classes used computers in a lab.[17] Similarly, English and science classes used presentation and graphical printing software, simulations, Web browsing, and multimedia software more frequently when computers were in the classroom.[18] Even using skill games in secondary academic subjects was more common when computers were in the classroom.

A shortage of individual computer stations in the classroom has long restricted more frequent, systematic, and well-integrated use of technology.

In addition, frequent use of the Web depends on having a sufficient number of classroom computers connected to the Internet. Although schools and classrooms have been connecting to the Internet rapidly in the past several years, as of 1998, only 3% of all secondary academic classrooms had both an Internet connection and four or more computers. The TLC-1998 data confirm that Internet resources such as the Web were twice as likely to be used frequently when a classroom had at least four simultaneous Internet connections than when it had a single Internet-connected computer.[19]

Of course, teachers who are prepared to use computers tend to demand greater access, so the correlation between having classroom access to computers linked to the Internet, and using those computers more

extensively, is not surprising. However, the computer's greatest value in academic classes is not generally for concentrated whole-class use on a scheduled basis, but instead as a resource for particular groups of students to find, analyze, or communicate information as the need arises on a more spontaneous basis. Thus, the presence of resources in the classroom is at least a necessary, if not sufficient, condition for integrating use of computers more effectively into the curricula. Other important conditions, including various teacher-related factors and the SES level of the school, are discussed below.

Teacher Computer Expertise

How likely students are to experience computers in intellectually powerful ways depends greatly on their teacher's expertise with computers. To use computers effectively in their classrooms, teachers must have certain levels of expertise in basic computer operations. Teachers have had to operate equipment such as movie projectors, slide projectors, and VCRs for decades, but the skills required to successfully operate computers—with all their varied functions—are much more complex and far removed from most other competencies required of teachers. Data from the TLC-1998 survey indicate that teachers' expertise with computers ranged from 75% who said they could display a disk's directory to only 18% who said they could develop a multimedia document.[20] And those teachers with the broadest expertise in using computers were the most likely to use applications on the leading edge of computer use in their subject. For example, computer-savvy teachers were more likely to use spreadsheets and presentation software in science classes, Web browsers in social studies classes, and e-mail in foreign language classes.

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Teacher Philosophy and Objectives for Computer Use

Beyond simply acquiring expertise in specific applications, however, teachers must also value the use of that application for enhancing the learning of important skills and content. Teachers are not likely to integrate a software application into the curriculum unless it is compatible with their instructional goals. As the data show, particular types of software were used more often when the applications were consistent with the teacher's philosophy and objectives for use of technology.[21] For example, the two types of software most commonly used by students under their teachers' direction were word processing and reference materials on CD-ROM. These applications paralleled the two objectives that teachers most frequently selected as most important for student computer use: "expressing themselves in writing" and "finding out about ideas and information." Similarly, teachers who assigned the use of presentation software were those who most valued computers for their role in helping students learn how to present information to an audience.

In addition, teachers were three times more likely to have their students use the Internet if they held more constructivist beliefs about teaching in general—that is, they believed in devoting attention to student interest rather than curriculum coverage, focusing on critical thinking and real-world applications, and using complex problem solving in small groups to help students learn—compared with teachers with more traditional beliefs and practices.[22]

Teacher Collaboration and Leadership

The data suggest further that those teachers oriented toward collaboration with each other and toward taking a leadership role in their profession are also the strongest users of technology. In nearly every subject, teachers who were "professionally engaged"—interacting with their peers on instructional and subject-matter issues and mentoring and teaching workshops for other teachers—were more likely to have their students use computers regularly during class, and with more types of software, than "private practice" teachers whose sole focus was on their own classroom.

The most significant differences were found in the use of software for communicating with others and creating products for an audience—activities closely associated

with constructivist beliefs. That is, professionally engaged teachers were much more likely than private practice teachers to use e-mail, multimedia authoring, and presentation software. Differences were even greater when the analysis considered the teacher's own professional use of and expertise in computer technology, as well as their use of software. The most professionally engaged teachers (that is, the 3% of all teachers who are also sometimes termed "teacher leaders") were 10 times more likely to be highly active computer users than were comparably skilled private practice teachers (40% versus 4%). Teachers in the latter group were more likely to emphasize curriculum coverage and direct instruction of facts and skills and simply did not find computers relevant to their concept of teaching.[23]

Teacher Judgments of Class Ability

In addition, the data indicate that students' use of computers varied according to their teachers' judgments about class ability levels. For example, across all subjects, classes categorized as low achieving used substantially more drill-and-practice exercises, whereas classes categorized as high achieving used more spreadsheet/database and e-mail software. Among teachers of the same subject, English teachers used word processing software much more often with high-achieving classes; computer and social studies teachers used presentation software more frequently with high-achieving classes; and social studies teachers used Web browsers more with high-achieving classes.[24] In general, the more salient a type of software was to a given subject, the more likely the teacher was to favor high-achieving classes for frequent use of that software.

The differential opportunity for higher-achieving students to use more intellectually complex software is the result of many factors, among them a teacher's expectations and beliefs about how different groups of students can use computers successfully.[25] Teachers of low-achieving classes may have found it difficult to use complex types of software with their students. If low-achieving classes are to experience more opportunities to work with complex software applications, teachers will need time and practice to develop methods for using such software successfully; otherwise, low-achieving classes are likely to continue using computers primarily for more narrowly focused drill-and-practice exercises.

School SES Level

Finally, the data show that students' use of computers in the classroom varied depending on the SES level of the community surrounding the school.[26] In particular, the ways in which students used computers were quite different in schools having mostly students from wealthier families compared with schools having mostly students from poorer families.

As discussed earlier, overall, a greater percentage of teachers reported weekly use of computers in low-SES schools than in high-SES schools. However, the data indicate that computer use in low-SES schools often involved traditional practices and beliefs about student learning, whereas computer use in high-SES schools often reflected more constructivist and innovative teaching strategies. For example, teachers in low-SES schools were more likely than those in high-SES schools to use computers for "remediation of skills" and "mastering skills just taught" and to view computers as valuable for teaching students to work independently. In contrast, teachers in high-SES schools were more likely to use computers to teach students skills such as written expression, making presentations to an audience, and analyzing information.[27]

Computer use in low-SES schools often involved traditional practices and beliefs about student learning, whereas computer use in high-SES schools often reflected more constructivist and innovative teaching strategies.

In addition, middle and high school students in low-SES schools are more likely to experience frequent computer use in different subjects than are students in high-SES schools. For example, students in low-SES schools were much more likely than students in high-SES schools to experience frequent computer use in a math class. Math classes account for 24% of all high-frequency computer experiences in the lowest SES-level schools, compared with only 6% of high-frequency experiences in other schools. In contrast, students in high-SES schools were

most likely to experience high-frequency computer use in science and computer classes. These courses account for more than 40% of all high-frequency computer experiences in high-SES schools, compared with only 12% in low-SES schools.

In sum, schools could play a critical role in helping to ensure equal access to computers for less-advantaged children. Although low-SES schools are beginning to catch up to high-SES schools in some benchmarks of access, the more sophisticated and creative uses of computers are not yet well linked with the curricula in core academic subjects, especially in poorer schools. For use of these more innovative software applications to become more widespread, greater numbers of computers must be accessible in academic subject classrooms—and greater numbers of teachers must be trained in and value the skills and experiences these applications have to offer.

Only about 22% of children in families with annual incomes under $20,000 had a home computer in 1998, compared with 91% of children in families with incomes of more than $75,000.

Home Computers and How They Are Used

Outside of school, children are most likely to access a computer in their homes. A home computer can provide children with a useful tool for helping them with homework and playing games. If connected to the Internet, a home computer can provide children with a vast array of material for both their education and entertainment, as well as a vehicle for informal "chats" or sending e-mail to friends and cybermates. The effects of children's access to computers at home are still being explored (see the article by Subrahmanyam and colleagues in this journal issue). However, the data describing children's access to and use of home computers in the United States are clear: the digital divide separating children in socioeconomically advantaged homes from children in socioeconomically disadvantaged homes is mammoth.

Access to Home Computers

Overall, children's access to home computers and the Internet has been increasing rapidly, according to data from the 1997 and 1998 CPS supplements.[2] In the 15 months between these two surveys, the proportion of children living in homes with computers increased by 4.6 percentage points (from 51.9% to 56.5%), and the proportion of children with home access to the Internet increased by 7.5 percentage points (from 26.5% to 34.0%). But some groups of children are much more likely to have access to home computers and the Internet than others. Income, education, and ethnicity are key predictors of access. The data also show that if parents use computers at work, they are much more likely to provide access to broadly functional computers at home. The extent of the disparities in home access for different groups of children is discussed further below.

Key Demographic Predictors of Access

The digital divide in access to home computers is illustrated dramatically in the data from the 1998 CPS. According to these data, the largest differences in access to a home computer and the Internet were between children from low-income and high-income families, and between children whose parents had limited education and children whose parents had graduate degrees.[28] As illustrated in Figure 5, only about 22% of children living in families with annual incomes under $20,000 had a home computer in 1998, compared with 91% of children living in families with incomes of more than $75,000. Similarly, only about 16% of children living with parents who had not graduated from high school had a home computer, compared with 91% of children with a parent having at least a master's degree.[29] In addition, community effects exacerbate the already large family-level SES differences in children's access to computers. Because of residential segregation by SES, children living in low-SES families without access to home computers also tend to live in low-SES neighborhoods, where they are less likely than children living in wealthier communities to have access through a neighbor or friend.[30]

The likelihood of children's home access to a computer and the Internet is also highly related to ethnicity. As shown in Figure 5,

African-American and Hispanic children were far less likely to have a computer or Internet access at home than other children. Earlier analyses of CPS data indicate that among households at the same income levels (whether or not children were present), African Americans are about three years behind, and Hispanics are about four years behind, white non-Hispanics in terms of their likelihood of owning home computers.[31] Even among families with similar incomes and parent education levels, most African-American and Hispanic children had at least 10% less access to home computers and the Internet than white non-Hispanic or Asian-American children.[32] Two interpretations of these findings are plausible. First, computers may be valued differently by the various ethnic groups. Second, economic factors not measured by current income—such as accumulated personal wealth—might enter into computer acquisition decisions.

In addition, children's access to home computers correlated highly with their parents' work-based experience with computers. According to data captured in the 1997 CPS supplement, children with two parents using computers at work are much more likely to have a computer at home than those with no parent using a computer at work (see Figure 6). Of course, much of this difference results from higher income and better-educated parents who are more likely to use a computer at work. However, even within SES groups, parents who use a computer at work are more likely to have a computer at home. In fact, work-based computer use appears to play an especially important role in increasing the likelihood of poorer and less-educated families having a home computer, holding other factors constant.[33]

In contrast with the differences based on income, education, ethnicity, and parents' work-based experience, differences in home computer access based on children's age and gender are quite small. The 1998 CPS data show variations in access between younger children and adolescents to be about 9%[34] and variations between boys and girls to be, at most, 1%.[35]

Quality of Access Also Linked to Demographics

Children's access to home computers can be described not only by the presence of a computer, but also by the computer's functionality and the number of computers in the household. Five features of functionality are important in providing access to a broad range of applications on a home computer:

- A hard disk drive,
- A CD-ROM drive,
- A printer,
- A modem (or other Internet access device), and
- A mouse (or other pointer control device).

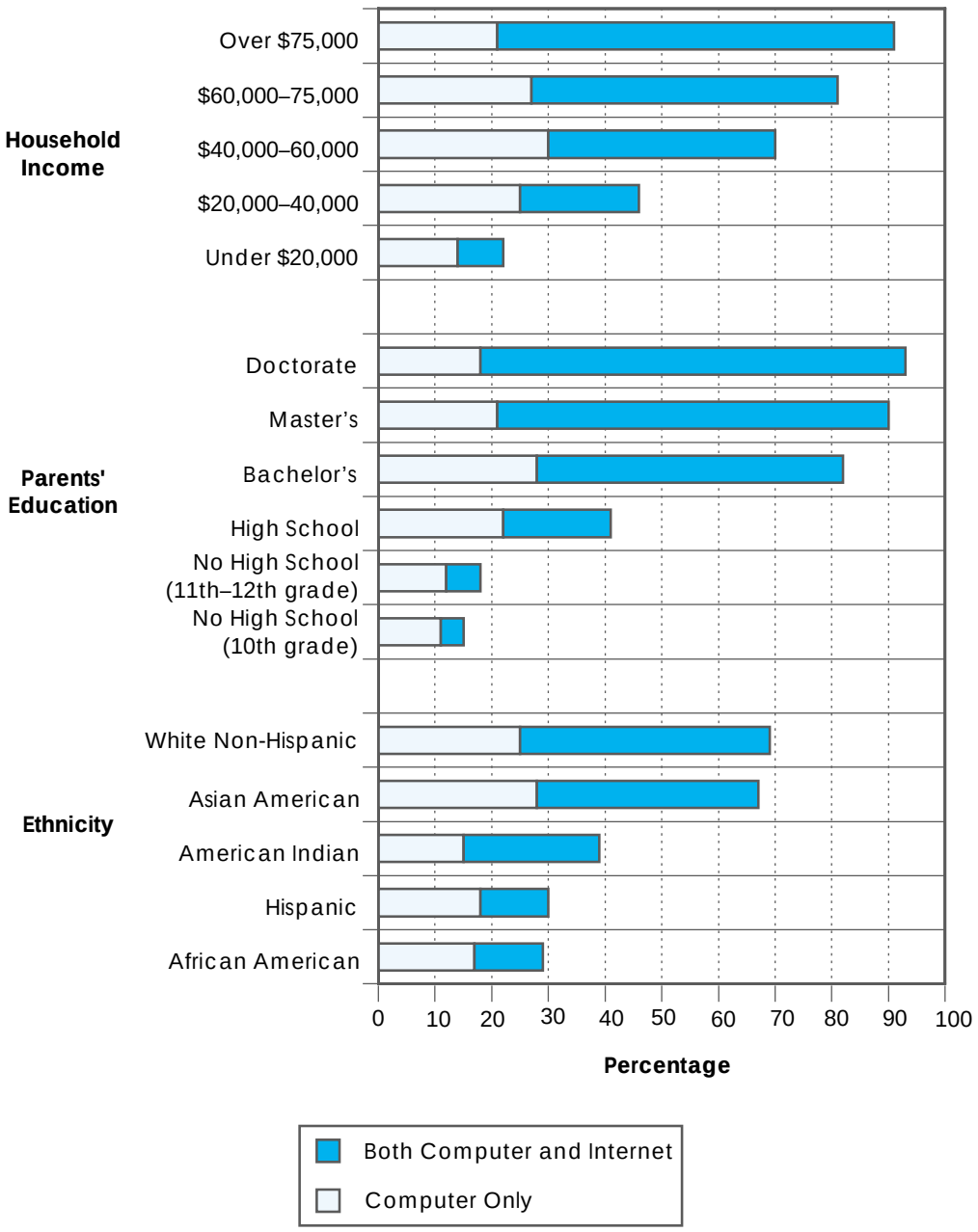
These features determine what the home computer enables children to do. Without hard disks and CD-ROM storage, for example, children cannot use information resources such as graphically appealing multimedia encyclopedias, complex simulation environments, or even literacy tools such as a thesaurus and spelling dictionary. Without printers, they cannot have hard copies of their creations for display. Without modems, they cannot access the huge world of information and communication provided by the Internet.

When the disparities in computer access are compounded by the disparities in computer functionality, the differences between some ethnic and SES groups are monumental.

As of late 1997, CPS data indicate that nearly 60% of children who had a computer of any kind in their home had access to a computer with all five features (about 30% of all children), and that about 25% lived in a multiple-computer household (about 12% of all children). How recently a household acquired a computer made some difference in the likelihood of a home computer having broad functionality. For example, 64% of home computers acquired in the previous year had all five features, whereas this was true of only 45% of those purchased in 1994 or earlier. Clearly, some homes upgrade older computers to meet new opportunities for functionality whereas others do not.

Figure 5

Children's Access to Home Computers and the Internet, by Family Income, Education, and Ethnicity, 1998

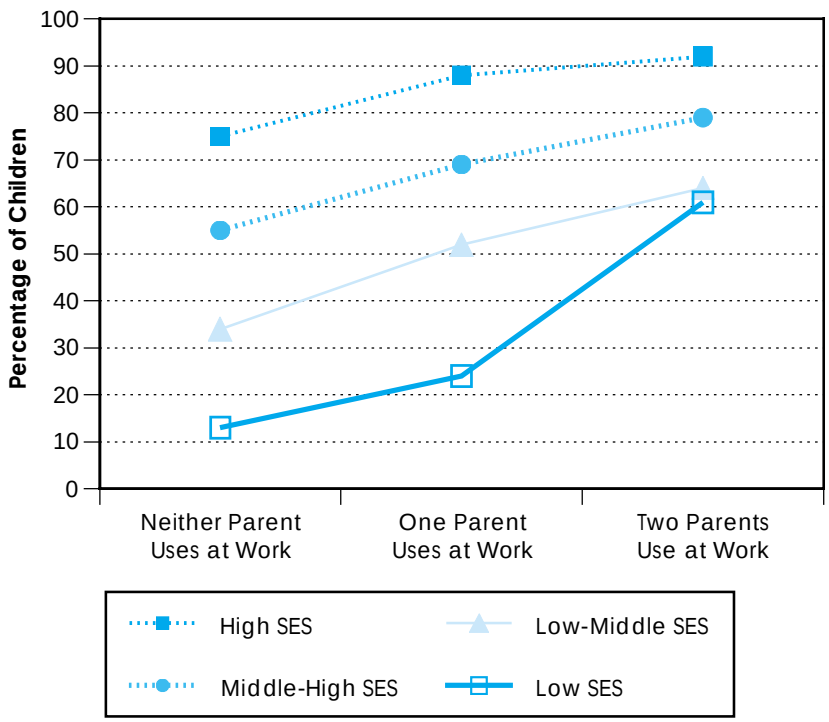


Note: Calculations were based on the number of households with computers and the Internet as a percentage of all households in each demographic group. Income was annualized based on weekly reports of income summed for both parents, when both were present in the child's household. Education is the maximum degree or years of school completed by either parent living in the household.

Source: Data analyzed from the U.S. Census Bureau's Current Population Survey of U.S. Households, December 1998 supplement.

Figure 6

Likelihood of a Home Computer Based on Parents' Computer Experience at Work, by Family Socioeconomic Status Quartile, 1997



Note: Family socioeconomic status (SES) quartiles were determined by combining family income and parent education into an SES index, arraying all children based on this index, then dividing them into four comparably sized groups from "low" to "high" SES.

Source: Data analyzed from the U.S. Census Bureau's Current Population Survey of U.S. Households, October 1997 supplement.

Income, education, and ethnicity are strong predictors of whether or not children have access to a home computer, as well as strong predictors of the quality of access. Even among households with computers, children living in families with higher incomes and education were much more likely to have a computer that had all five features of functionality or to have multiple computers in their homes.[36] But when the disparities in computer access are compounded by the disparities in computer functionality, the differences between some ethnic and SES groups are monumental. Table 3 lists the groups of children who were most and least likely to have quality access to a home computer from among all families, not just those with computers, according to 1997 CPS data.

Similarly, parents' experience with computers at work is also, once again, linked to quality of access. In households with computers, a child's likelihood of having a broadly functional computer and multiple computers present was significantly greater when two parents used computers at work (see Figure 7).[37]

The evidence presented here suggests that the digital divide separating socioeconomically advantaged and disadvantaged children in their access to home computers is quite large, and may be growing even larger. Even as poor families with little education obtain basic computers, limited software, and modems to link to the Internet; wealthier and more educated families obtain multiple computers, sophisticated software,

and high-speed links to the Internet. Moreover, many uses of computers require skills and experience in information management and other technical areas that socioeconomically disadvantaged children are less likely to procure through family, friends, and personal opportunity.

Home Computers Used Most for Games and Schoolwork

As of 1998, just about the same percentage of homes had computers as did classrooms: 57% of homes with children and adolescents had computers,[38] and 51% of 4th- through 12th-grade classrooms had computers.[39] At school, however, a student's opportunity to use computers is constrained by the regimentation of the daily schedule and the number of students sharing available resources. In contrast, at home, a child's opportunity to use a computer depends more on the child's own interest, prerequisite skills, and available time.[40] These factors suggest that children are more likely to use a computer at home than a computer at school. According to CPS data, when a computer was present in the home, nearly 9 of 10 children used it to some extent.[41] With a computer in slightly more than half of all children's homes, that translates to about 45% of school-age children being home computer users. But how often and for what purpose these children use their home computers is also important.

Children's growing Internet use is oriented at least as much toward recreational pursuits as toward formal learning.

About 60% of the children in families owning computers were reported to be "regular users," using the home computer at least three days per week, according to the 1997 CPS data. At the same time, playing games has always been the primary use of home computers for children. Some computer games teach school-related skills, but only about half as many parents reported their children's use of home computers for educational programs as reported use for playing games. Thus, despite claims by most parents that their children's use of home computers has some relationship to school, the educational value of the games they play may be fairly modest. After games, however, the next most frequently reported activity on the home computer for children older than age eight was use specifically for school assignments.

Perhaps surprisingly, given the recent growth of and media attention surrounding the Internet, as of 1998, more children used home computers to run stand-alone software than to go online. Only about 34% of school-age children lived in households with home Internet access. Often, children did not use the Internet even when available—its use limited by cumbersome access and by a child's age.[42] However, children's use of home computers to access the Internet has been growing rapidly. In the 15 months between the 1997 and 1998 CPS surveys, home use of the Internet among children and adolescents grew from 14% to 23%.[43]

In addition, several surveys have found that those children who use the Internet go online rather frequently. For example, a Roper-Annenberg survey of parents found that half of the children ages 8 to 17 using the Internet from home were reported to use it about once every three days.[44] Another survey of children themselves found even higher rates of access: 60% of Internet users said they used the Internet at least once per week, and 15% said they used it every day.[45] Although only a small minority of all 8- to 17-year-olds engage in such frequent home Internet use, the diffusion of this relatively new technology among young people has been quite rapid.[46] In a global survey including 1,000 American households with a connection to the Internet, teens ages 13 to 19 were found to use online services significantly more than adults, even young adults ages 20 to 29.[47]

For the most part, the types of activities children engage in through the Internet parallel those for computer use in general. In both the CPS and Roper-Annenberg surveys, the most commonly reported single home-based Internet activity for teens was "homework" (38% in Internet households; 13% of all children). Similarly, in the CPS study, parents reported that more children used the Internet to do "research for school"

Table 3

Children's Likelihood of Quality Access to a Home Computer, by Demographic Group, 1997

	Percentage of Demographic Group with Quality Access to Home Computers, As Measured by the Presence of-	
	A Broadly Functional Computer	**Multiple Computers in the Home**
Five demographic groups most likely to have quality access		
Children with a parent who has a professional or doctorate degree	52%	32%
Children in families with incomes of more than $75,000	56%	28%
Children with a parent who has a master's degree (but none higher)	50%	23%
Children in families with a parent in a managerial or professional occupation	43%	20%
Children with a parent who has a bachelor's degree (but none higher)	42%	20%
Five demographic groups least likely to have quality access		
Hispanic children	13%	5%
African-American children	10%	4%
Children with a parent employed in a blue-collar or service occupation	10%	2%
Children in families with an income of less than $20,000	7%	3%
Children with no parent who graduated from high school	4%	1%

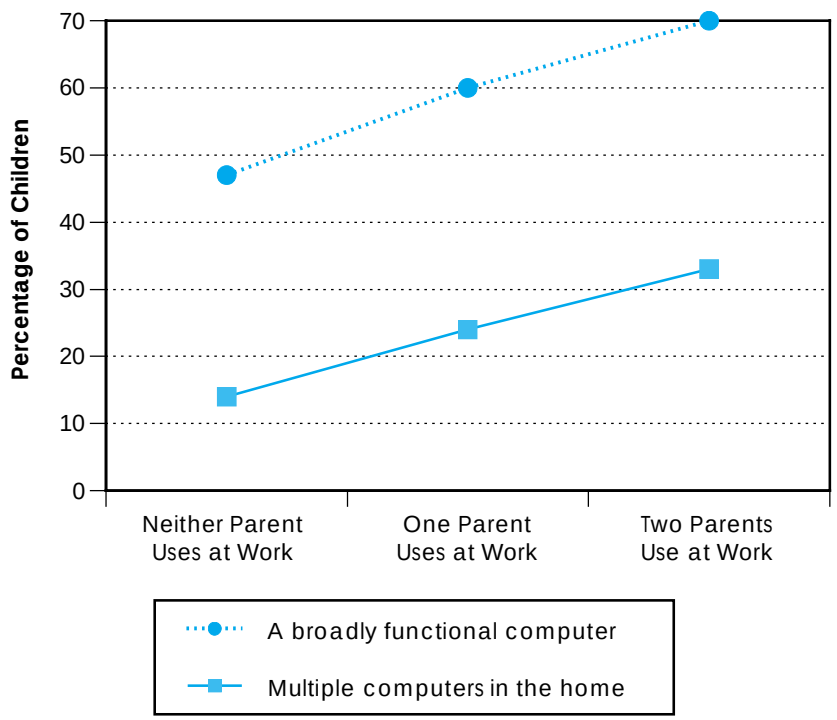
Note: A broadly functional computer is defined as one with the following five features: a hard disk drive, a CD-ROM drive, a printer, a modem (or other Internet access device), and a mouse (or other pointer control device).

Source: Data analyzed from the U.S. Census Bureau's Current Population Survey of U.S. Households, October 1997 supplement.

than any other activity (20% of all children). However, both studies found that most other Internet activities were recreational in nature—such as e-mail, chat rooms, Web-based games, Web surfing, and listening to music—and that taken together, more time was spent on these predominantly recreational activities than on school-related work.[48] In addition, as illustrated in Figure 8, children's use of the Internet for e-mail increased dramatically between 1997 and 1998, whereas use of the Internet for information retrieval remained the same or even declined for all but the youngest age group. Thus, the data indicate that children's growing Internet use is being driven more by their personal choice than by teacher directives, and that it is oriented at least as much toward recreational pursuits as toward formal learning.

Figure 7

Likelihood of Quality Access Among Families with Home Computers, Based on Parents' Computer Experience at Work, 1997



Note: A broadly functional computer is defined as one with the following five features: a hard disk drive, a CD-ROM drive, a printer, a modem (or other Internet access device), and a mouse (or other pointer control device).

Source: Data analyzed from the U.S. Census Bureau's Current Population Survey of U.S. Households, October 1997 supplement.

Although much of children's increasing activity on the Internet appears to be for entertainment rather than education, recreational uses can help children develop competencies that have academic value. For example, playing games may enhance strategy and planning skills, and using e-mail may improve verbal skills. Therefore, the question still remains whether or not children and teens who are heavy users of home computers and the Internet—even if primarily for recreational pursuits—are nevertheless gaining skills, knowledge, and educational advantages compared with those who lack such access.

Factors Affecting Use of Home Computers

Among families with home computers, some children and adolescents are more likely to take advantage of that technology than others. To determine which factors have the largest effects on the frequency and type of children's use of home computers, data on more than 11,000 children from the 1997 CPS were analyzed. Results of this analysis indicate that the age of the child was the strongest predictor of use. The functionality of the computer and the experience of family members also were important factors. Family SES level was still found to be significant, but gender was found to have little effect on children's use of home computers.[49]

Age of Child Most Strongly Linked to Use

With few exceptions, the 1997 CPS data indicate that older children used the computer more often and with different applications and types of software than did

younger children. Early adolescents (ages 12 to 14) appeared to use home computers somewhat more than all other age groups analyzed, including both older teens (ages 15 and older) and preteens (ages 9 to 11). The youngest children studied (ages 6 to 8) used the computer significantly less often than the older children for most activities except educational programs and games (see Figure 9).[50] However, as mentioned earlier, more recent data indicate that use of the Internet has been increasing rapidly, especially among younger children. Younger children may simply be following the lead of older children—or they may be responding to the growth in professionally organized Web-based activities and Web sites oriented toward younger age groups (see the article by Montgomery in this journal issue).

The Computer's Features and Family's Experience Also Important

The functionality of the home computer was the second strongest predictor of children's home computer use, followed by the family's computer experience. Children, especially older teens, used their home computers more frequently and with a wider variety of applications when the computers had all of the features used to define full functionality: a hard disk drive, a CD-ROM drive, a printer, a modem, and a mouse or similar pointer control. Internet applications and educational software were most affected by home computer quality because they require the extra features of a modem and CD-ROM.

The computer experience of family members, both inside and outside the home, also affected children's home computer use.[51] Parents' work experiences with computers had the broadest effects across a majority of the measures. Parents' knowledge and experience appeared to help children ages 9 to 11 in particular with such applications as e-mail and the Web. To a lesser extent, parents' experience with diverse software appears to help older children with some of the more complex computer applications, such as desktop publishing and spreadsheets. Children also were more likely to use home computers if their older siblings did so and if they used computers themselves at school. Among the youngest children studied, computer use at school was linked to computer use at home for a variety of basic applications, from educational software to computer games.

SES Level Still Significant

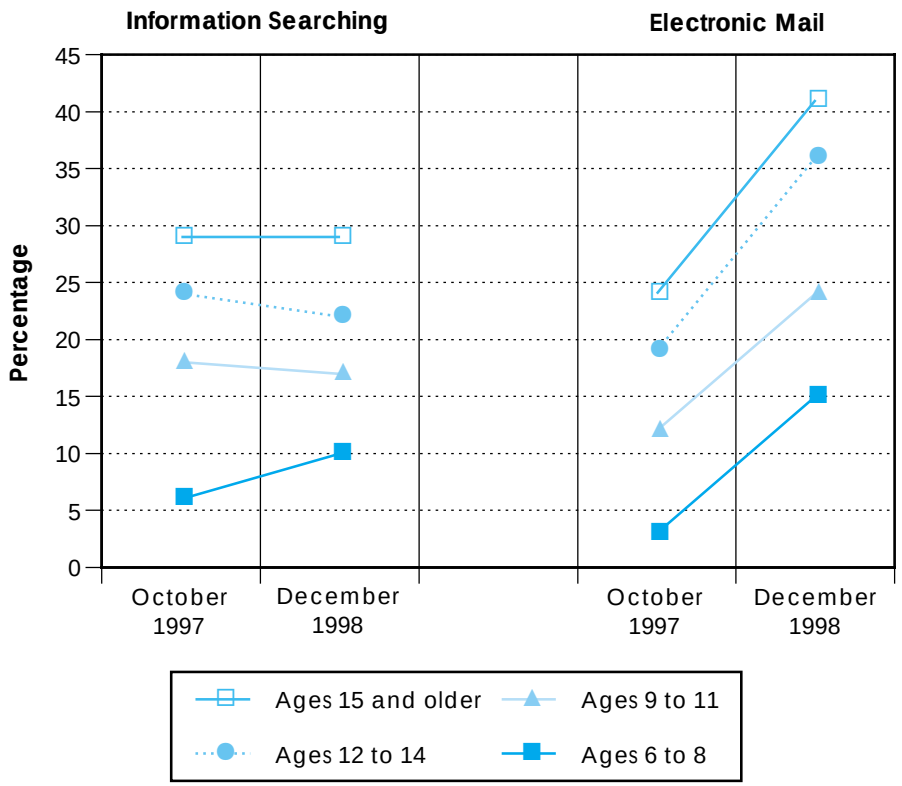
Just as children in families with lower income and less-educated parents were much less likely to have a computer in their home—or, if they had a computer, to have one with many features—such children were also less likely to use their family's computer in various ways. Data from the 1997 CPS supplement indicate that, even among computer-owning families, children who were socioeconomically more advantaged were more likely to use each of the six applications measured (see Figure 10). SES disparities were greatest in children's use of home computers for word processing: 50% of the children from high-SES families with home computers used word processing, compared with only 24% of the children from low-SES families with home computers. If all children in each SES group are considered—not just those with a computer at home—the differences become enormous: 44% of all high-SES children reported use of home computers for word processing, compared with fewer than 4% of all low-SES children. Such data make clear that children from lower-SES families are far less likely to use computers at home for what many middle-class children experience as common, ordinary activities.

Children from lower-SES families are far less likely to use computers at home for what many middle-class children experience as common, ordinary activities.

In this analysis of factors, however, two of the factors already discussed—home computer quality and parents' computer use at work—were found to account for a large part of the relationship between SES and children's use of home computers. That is, the SES differences in children's use of educational software and e-mail on their home computers were much smaller among families with computers with the same level of functionality and among families whose parents have the same level of

Figure 8

Changes in Children's Reported Use of Home Computers Between 1997 and 1998, by Age



Sources: Data analyzed for children in homes with computers, from the U.S. Census Bureau's Current Population Survey of U.S. Households, October 1997 and December 1998 supplements.

work-based computer experience. Still, even when these two factors are held constant, higher-SES children used a wider range of applications overall—and word processing in particular—than did lower-SES children.

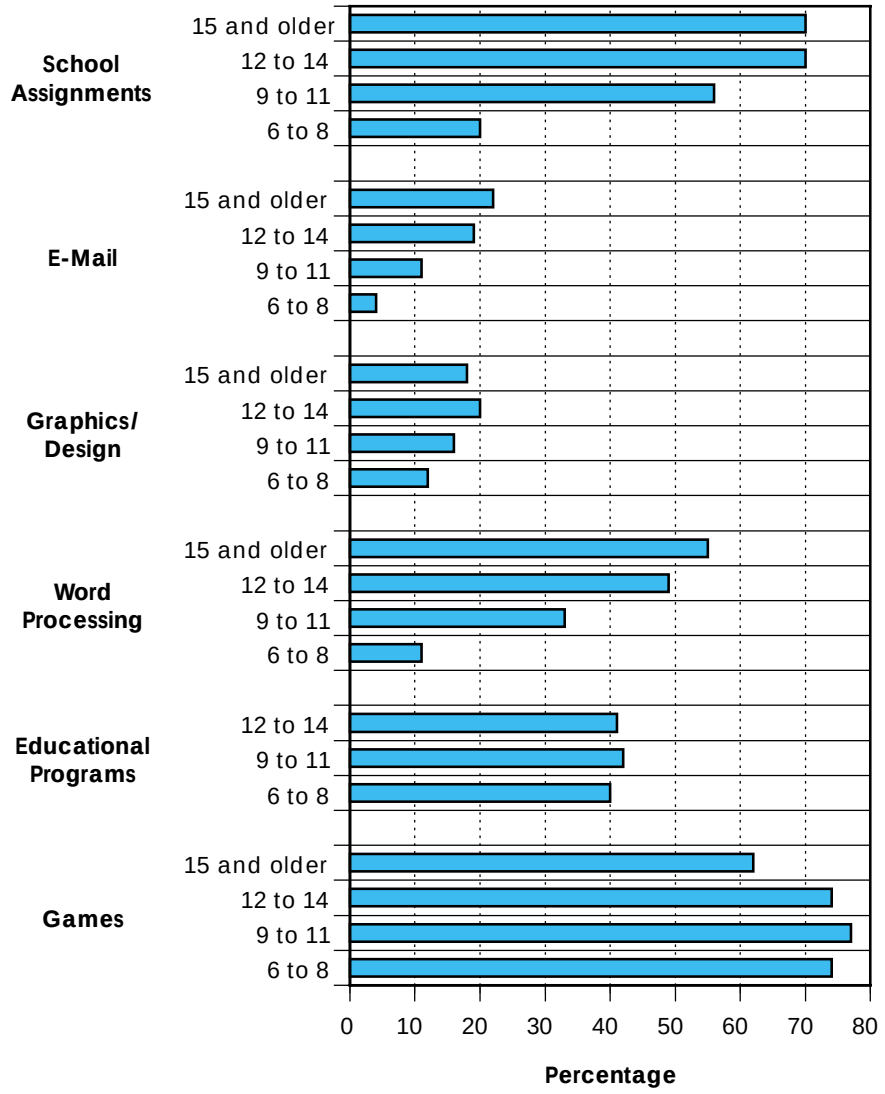
Gender Found to Have Little Effect

The analysis of 1997 CPS data found similar patterns of home computer use for both boys and girls. Adolescent girls were reported to use computers three or more days per week nearly as often as were adolescent boys (30% versus 31% for ages 15 to 17; and 34% versus 37% for ages 12 to 14).[52] Only small differences existed between the percentages of same-age boys and girls using home computers for any given activity. The largest gender differences were in the use of games (75% for boys versus 68% for girls) and word processing (36% for boys versus 41% for girls). Boys' and girls' reported use of home computers for other activities did not vary by more than one or two percentage points.[53]

In addition, the 1998 CPS data found boys and girls were equally likely to use the Internet from home; types of Internet use again varied only slightly.[54] Other surveys have shown more significant gender differences, however. For example, the 1998 *Roper Youth Report* found that girls were more likely to socialize online through chat rooms, e-mail, and surveys on Web pages, whereas boys were more likely to play online games and download software.[45] The main issues regarding gender may have less to do with access or categories of software used, however, than with attitudinal and interest dimensions.[55] (For further discussion of gender issues, see the article by Subrahmanyam and colleagues in this journal issue.)

Figure 9

Percentage of Children with Home Computers Reported to Use Different Types of Software, by Age Group, 1997



Note: Children age 15 and over were not asked about their use of educational programs.

Source: Data analyzed from the U.S. Census Bureau's Current Population Survey of U.S. Households, October 1997 supplement.

In sum, among families with home computers, children use the computer as much for entertainment as for educational purposes. Key factors affecting how often a child uses a home computer—and for what—are the age of the child, the presence of a broadly functional computer, experienced family members, and family SES. Older children from more advantaged backgrounds, and those with a broadly functional computer and experienced family members, are more likely to use a home computer more often and with a wider variety of software than are younger, poorer children and those without such equipment and support. However, whereas disparities in children's access to home computers persist, it appears that once children have access, some gaps in home computer use—such as between younger and older children and between boys and girls—are closing.

Summary and Interpretations

The images of a new Net generation of children at the start of this article certainly have some truth to them. Just as widespread access to computers and the Internet is rapidly diffusing ideas, information, and skills among adults with common interests, it is also enabling teens and even younger children to learn more about what interests them. Little in the data examined here would lead to the conclusion that most teenagers are broadly sophisticated computer users, however. Most computer use at schools falls short of helping students reach a high level of mastery, and most computer use at home is too entertainment oriented to have a major impact on children's intellectual or technical competencies.

Access to computers and the Internet is necessary for children to grow up with the information-gathering, analytic, and written and graphical communications skills that will constitute "being educated" in the twenty-first century.

Yet the surveys analyzed here are but a snapshot in a highly dynamic situation. As schools and homes acquire more and newer computers, and as more young people spend more time using computers and the Internet in diverse ways, the Net generation is becoming a reality. The following discussion provides a brief summary of key conclusions and interpretations to guide efforts to invest effectively in future technology and to ensure more equal access and use of computers for all America's children.

Access to Computers and the Internet: Necessary, But Not Sufficient

Access to computers and the Internet is a necessary, but not sufficient, condition for children to grow up with the information-gathering, analytic, and written and graphical communications skills that will constitute "being educated" in the twenty-first century. Children must have access to an adequate quantity and quality of computers in their classrooms and homes, and knowledgeable adults or older peers must be available to help children learn to use the variety of software applications.

Nearly all children have access to computers at school. Low- and high-SES schools are about equally likely to meet a suggested standard for per capita computer presence. For the most part, however, only those students taking computer, business, or vocational education classes have ready access to computers in a classroom where other learning activities are taking place. Most academic classrooms with computers have too few to permit easy access to large numbers of students at one time.

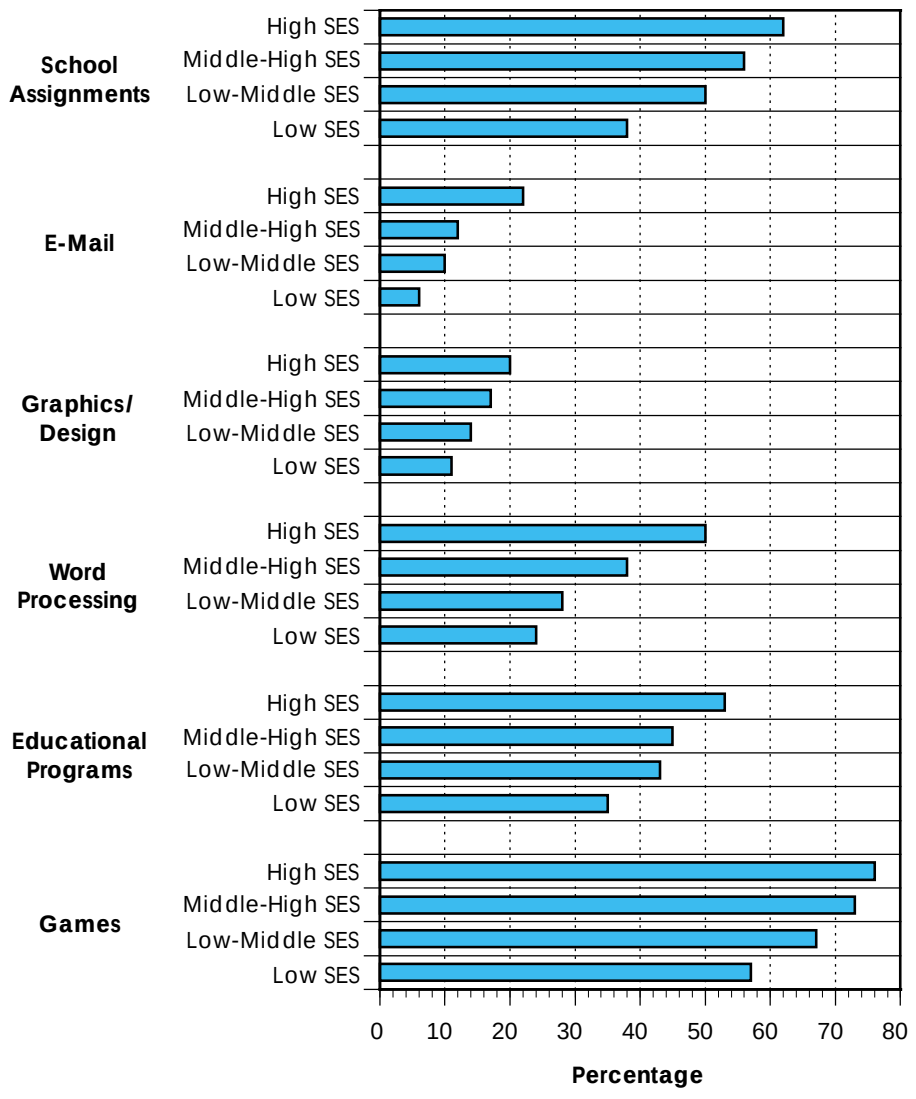
In contrast, only about half of our nation's children have access to computers at home. The disparities in access between children in low-SES and high-SES families are simply enormous. For example, whereas 91% of children in families with incomes of $75,000 or more have a computer at home, only 22% of children in families with incomes of less than $20,000 have home computers. The large family-level SES differences in children's access to home computers are further exacerbated by residential SES segregation, with children living in poorer neighborhoods also having less access through a neighbor or friend, compared with children living in wealthier communities.

The data show that when parents use computers at work, however, they are much more likely to provide their children with access to computers at home, especially those in low-income families. Employers could reinforce this connection and help even more disadvantaged families gain access to home computers by extending their hardware and software contracts to employees for private purchase, thus making computer access available to families at a much-reduced price. Some companies have gone a step further and actually purchased computers for employees to use at home, including access to the Internet, for a nominal monthly fee.[56]

Even when computers are present in classrooms and in homes, however, the computers' capabilities, location, or rules gov-

Figure 10

Percentage of Children with Home Computers Reported to Use Different Types of Software, by Family Socioeconomic Status, 1997



Note: Family socioeconomic status (SES) quartiles were determined by combining family income and parent education into an SES index, arraying all children based on this index, then dividing them into four comparably sized groups from "low" to "high" SES.

Source: Data analyzed from the U.S. Census Bureau's Current Population Survey of U.S. Households, October 1997 supplement.

erning use may restrict access. High-SES schools and families generally have more modern computing equipment and provide more widespread Internet access. As of 1998, low-SES schools were only about half as likely as high-SES schools to have high-speed Internet access. Similarly, low-SES families were much less likely to have home computers that were broadly functional or connected to the Internet. Thus, although both schools and families have been investing in modernizing their computer technology, continued upgrades are needed as capabilities of computers increase; the least-advantaged may find it difficult to keep up with technological change.

In addition, computers are not accessible in practical terms when they are located in inhospitable locations—such as a principal's office or a parent's private study. Even a concentrated location in a computer lab—which appears to give students more opportunities to use computers (and may result in lower total outlays for equipment)—may restrict use when shared by several teachers, requiring prior scheduling and extensive preparation. Nor does physical access guarantee use if heavy-handed regulations restrict how and when computers are to be used; for example, if software at public libraries or schools is restricted to approved titles, or access to the Internet is limited to approved Web sites or allowed only when an adult is present.

Although much of children's use of home computers may be for entertainment rather than educational purposes, such experiences nevertheless may have academic value.

Frequent or Repeated Use: Necessary for Most Meaningful Consequences

What children and adolescents are gaining from their access to computers depends, in large part, on the frequency and duration of use. The limited data on patterns of use indicate that about half of all students use computers at school several times per week. Over the course of a school year, a majority of students receive substantial exposure to computers in at least one of their courses. Most intensive experiences occur in classes whose goals are learning about computers or preparing for specific occupations rather than in academic classes where the technology is used as a resource for learning subject matter and competencies. Progress has been made over the past decade in integrating computer-based activities into subject-matter teaching, but a long road remains before such integration becomes a common, everyday occurrence in most academic middle and high school classes.

The typical school currently has nearly one-half of its computers in shared computer labs, whereas the typical academic classroom has only one or two computers. One approach to facilitating more frequent, integrated computer use in core subjects would be to have students use their Web access in computer classes for research related to assignments in academic classes. Given that within-class access is needed for well-integrated use of technology, however, moving computers out of labs and spreading them among academic classrooms would be a more desirable approach to facilitating better-integrated use of computers in core subjects.

In families with home computers, nearly 9 of 10 children used the computer to some extent, with most using the computer at least three days per week. Recent surveys of Internet use found that American teenagers ages 13 to 19 used online services significantly more than any other age group, including adults. Although much of children's use of home computers may be for entertainment rather than educational purposes, such experiences nevertheless may have academic value, providing skills and knowledge that those without access are deprived of comparable opportunities to develop.

The Nature of Computer Experiences: The Most Critical Variable

If children are being changed by their experiences with computers, how they are being changed depends on the types of computer activities in which they are engaged. In school, children's most common computer experiences involved word processing and information acquisition.[57] At home, children's experiences with computers on the whole appeared to be more recreational than school related—with children spending as much time playing games or using e-mail as completing school assignments or searching for information on the Web. Aside from games, the most common use of home computers for older children and teens was the same as at school: word processing. In its best use, word processing helps children articulate their thoughts verbally, enhancing their thinking processes and their ability to communicate with others. However, to achieve these outcomes, teachers must direct and encourage students to take advantage of the editing and reformulating capabilities that word processing provides. In

addition, although the increased use of information-acquisition applications (such as CD-ROM references and the Web) in core subject classes is promising, other computer applications that might also be linked to academics have made little headway into common practice.

Efforts to design appropriate software tools and educational environments such as those described by Roschelle and colleagues in this journal issue are laudatory, but curriculum development and teacher training and orientation must change before such tools are widely adopted. Integration of innovative educational software tools and virtual educational environments into standard curricula is difficult, requiring many stages of adoption by intermediaries (for example, educational publishers, state educational policymakers, and school district curriculum leadership), and adaptation to conditions that are less favorable than initial pilot sites. Moreover, teachers must value computers for compatible instructional goals before they actively use related software in their classrooms. To influence teachers' instructional use of computers, simply training them in the use of certain types of software will not suffice. Unless teachers believe tools such as simulation and presentation software can enable students to gain important academic competencies, they will be reluctant to incorporate such sophisticated applications into the curricula.

Thus, until the challenges of curriculum development and teacher training and orientation are faced and met, the more complex and intellectually powerful computer applications will be used much less often than the word processors, Web browsers, CD-ROM titles, and game-like skills-practice programs that dominate most school computer use today. To better understand the value of different types of computer experiences—both at school and at home—careful studies are needed of how children and adolescents are affected, academically as well as socially.

Conditional Effectiveness: The Importance of Context

Finally, the survey data discussed in this article demonstrate that children and adolescents' computer access and patterns of computer use vary widely depending on the school's SES level and the child's family circumstances. Children in higher-SES schools are advantaged not so much by greater access to computers, but by access to a teaching approach that emphasizes use of technology for developing higher-order skills.

All schools provide about the same access to computers, but higher-SES schools—and in particular, the higher-achieving classes in those schools—generally use computers in more intellectually powerful ways. The main advantage for students in higher-SES schools is their access to a teaching approach that enables them to master computer skills in the context of solving real problems and gaining deeper understanding of an area of study, compared with an approach more common in lower-SES schools that emphasizes skills reinforcement and remediation.

These school-based inequalities simply add to the home-based SES disparities in children's access to computers. Efforts to ensure equal access to computer-related learning opportunities at school must move beyond a concern with the numbers of computers in different schools toward an emphasis on how well those computers are being used to help children develop intellectual competencies and technical skills. Certainly, lower-performing students and students from economically poorer backgrounds can profit from greater competency in arithmetic and literacy. Targeting computer opportunities to those limited domains, however, will exacerbate these students' disadvantage compared to more advantaged students who use their computer access to gain mastery of higher-order skills and competencies. Schools in lower-SES areas can help counteract private disadvantage only if they strive to obtain more advanced technology and adopt better strategies of integrating its use with classroom learning.

Inevitably, young adults will become increasingly "technology sophisticated." Whether most children will gain this sophistication, or whether these competencies will develop only among an advantaged minority, will depend on the private and public policy choices made in local schools and in other public and commercial enterprises. The data analyzed in this article show us only where we are starting from; our challenge is

to be sure that the data collected a decade from now will look quite different.

This paper profited greatly from unusually detailed editorial assistance by Margie Shields, issue editor. Taking a manuscript three times its eventual length, Margie enabled the paper to present in a clear and efficient manner nearly every empirical result that it had originally contained.

1. In the national survey, *Teaching, Learning and Computing: 1998–A National Survey of Schools and Teachers* (TLC-1998), data were gathered about teachers' pedagogy and practices and their use of computers. These data were gathered from 2,251 teachers in more than 600 schools in a national probability sample (a weighted representative sample), as well as from 1,800 other teachers in more than 500 schools specially selected because they had a high density of computer technologies or were systematically involved in instructional reform. These specially selected schools included those participating in 50 major national educational reform programs. Descriptive statistics from the TLC-1998 study calculated or reported for this article are based on the representative sample only; more analytic statistics, such as the relationship between computer use practices and conditions of use for teachers in specific subjects, also include the sample from the specially selected schools. Of all schools surveyed, 75% participated; 68% of teachers selected from the participating schools responded. See the project's homepage at http://www.crito.uci.edu/TLC.
2. The U.S. Census Bureau's Current Population Survey of U.S. Households' October 1997 supplement included data on computer use for 23,026 children ages 6 to 17 (plus 18- and 19-year-olds still attending high school). The December 1998 supplement included data on Internet use for 23,337 children of similar ages. The CPS methodology is described online at http://www.bls.census.gov/cps/computer/1998/smethdocz.htm. For the NTIA report of the 1997 CPS survey, see McConnaughey, J.W., and Lader, W. *The digital divide: A survey of information "haves" and "have nots" in 1997* (also known as *Falling through the Net II: New data on the digital divide*). Washington, DC: U.S. Department of Commerce, National Telecommunications and Information Administration. For the NTIA report of the 1998 survey, see National Telecommunications and Information Administration. *Falling through the Net: Defining the digital divide.* Washington, DC: U.S. Department of Commerce, July 1999.
3. Anderson, R., and Ronnkvist, A. The presence of computers in American schools. *Teaching, learning and computing: 1998–A national survey of schools and teachers, report #2*. Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, and University of Minnesota, June 1999. Available online at http://www.crito.uci.edu/TLC.
4. Executive Office of the President of the United States, President's Committee of Advisors on Science and Technology. *Report to the President on the use of technology to strengthen K–12 education in the United States.* Washington, DC: U.S. Government Printing Office, March 1997.
5. *Internet access in U.S. public schools and classrooms: 1994–99*. Stats in brief. Publication no. NCES 2000–086. Washington, DC: National Center for Education Statistics, February 2000. This is largely the result of schools having made the transition from systems of individual computers connected via dial-up telephone lines to high-speed direct Internet connections spread to many rooms simultaneously through a local area network of cables linking school computers and printers. NCES data indicate that the percentage of schools with dial-up connections decreased from 39% in the fall of 1996 to only 14% by the fall of 1999.
6. "Low-SES" schools are defined here as schools with 40% or more of students eligible for assistance under the Education for the Disadvantaged program, also known as Chapter 1; "high-SES" schools are defined as schools with fewer than 10% of students eligible for such assistance. In a comparison of low- and high-SES schools, the TLC-1998 data indicate the percentages having a high-speed ("T1") Internet connection were respectively 23% versus 42%; the percentages having an Internet-connected computer-to-student ratio of 1 to 12 were 17% versus 44%; and the percentages having half of the school's classrooms with a high-speed Internet connection were 12% versus 29%. These are figures from prior to the government's "E-rate" program, which provides funding for schools and libraries to install wiring. See Appendix A by Roberts in this journal issue.
7. Becker, H.J., Ravitz, J.L., and Wong, Y.T. Teacher and teacher-directed student use of computers and software. *Teaching, learning, and computing: 1998–A national survey of schools and teachers, report #3.* Irvine, CA: Center for Research on Information Technology and Organizations,

University of California, Irvine, and University of Minnesota, revised December 1999, p. 7. Available online at http://www.crito.uci.edu/TLC.

8. The pattern of frequent computer use in middle schools and high schools is similar. The small differences in proportions reflected in the data are due, in part, to the fact that fewer applied courses are offered in the middle school than in the high school curriculum.

9. For more detailed data on high-frequency computer use in middle and high school classes by school SES level and subject, see Becker, H.J. Who's wired and who's not. *Teaching, learning and computing: 1998 A national survey of schools and teachers* . Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, 2000. Available online at http://www.crito.uci.edu/TLC.

10. Studies of instructional uses of school computers conducted in the 1980s and the early 1990s found that, except for practicing basic math skills and playing learning games as a supplementary "reward" activity, most school computer experiences during this period focused on making students "computer literate." Typical experiences included learning computer-specific skills such as programming (primarily prior to 1985) or word processing (primarily since 1985). However, systematic opportunities for students to apply such computer skills to academic tasks, such as developing or demonstrating an understanding of course subject matter, were much more rare. In 1992, 11th-graders spent only 31% of their school computer time for work in academic classes. Of their total computer time at school, 45% was in computer education activities, 17% in business education or vocational classes, and the remainder was recreational use. See Becker, H.J. Analysis and trends of school use of new information technologies. Paper prepared for the Office of Technology Assessment, U.S. Congress, under contract no. K3-0666.0. Irvine, CA: University of California Department of Education, 1994, Table 4.1.

11. College Board trend studies of high school students taking the Scholastic Aptitude Test (SAT) for college admission support the data collected in the TLC-1998 study. As of 1997, some 75% of students taking the SAT had used computers for word processing; 45% had used them in some way in their English courses. However, only about 25% had used computers for math problem solving, and even fewer had used them for science (13%) or social studies (8%). On the basis of the trend data collected between 1987 and 1997, nearly all university-bound students will be using word processing in high school by 2000, but only a minority will use computers for problem solving in other classes: under 30% in mathematics, 20% in science, and 10% in social studies. See *1997 college-bound seniors: A profile of SAT program test takers.* Princeton, NJ: College Board, 1997.

12. By 1998, more than 24% of U.S. teachers were using the World Wide Web with students on a weekly basis. More than 66% of all teachers, across all subjects, were Web users themselves, primarily for identifying information resources for use in lessons or for use by their students. Becker, H.J. Internet use by teachers. *Teaching, learning and computing, report #1.* Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, 1999, p. 4. Available online at http://www.crito.uci.edu/TLC.

13. To the extent that boys and girls have different patterns of choosing elective courses, the genders may experience computers in school differently; however, the evidence for such gender differences is mixed. Traditionally, girls have been underrepresented in vocational education classes, but they have been overrepresented in business education classes, where computers and increasingly sophisticated software are used a great deal. The TLC-1998 data do not include information about the different ways in which boys and girls use computers. Most data regarding gender differences in computer use derive from about 15 years ago, when systematic computer use was just beginning in American schools. See, for example, Becker, H.J., and Sterling, C.W. Equity in school computer use: National data and neglected considerations. *Journal of Educational Computing Research* (1987) 3:289–311. For a well-done ethnography of gender issues in the use of computers to teach a single subject (geometry) based on observations from 1985–87, see Schofield, J.W. *Computers and classroom culture.* New York: Cambridge University Press, 1995.

14. Experiencing the newer and more creative uses of computers only in nonacademic classes is probably not as meaningful or constructive as experiencing intellectually powerful applications in core academic classes. However, curricular demands and structural constraints (especially) on high school academic teachers—as well as teachers' own objectives and priorities, discussed later in this article—have so far greatly impeded the integration of more demanding computer tools into teaching practice.

15. In comparison, more than 80% of teachers of computer education classes and 67% of business education teachers had enough classroom computers to provide a ratio of at least one computer for every four students enrolled. Differences in classroom access to computers account for most of the differences between school subjects in how likely it is that students get to use computers on a frequent basis (discussed earlier).
16. More specifically, 55% of classes with five to eight classroom computers used them frequently, compared with 21% of classes using computers in labs.
17. About one-third of science teachers with five or more classroom computers had their students use spreadsheets or database programs on at least 10 occasions, compared with only 6% of science teachers whose classes had access to a large computer lab instead. Math teachers were less likely to have their classes use those types of software, but again, those with five computers in their classroom were much more likely to do so than those whose classes used a lab (12% versus 1%).
18. Social studies teachers also tended to use more sophisticated software when five or more computers were in the classroom, but there were too few social studies teachers with such access in the TLC-1998 study (N=14) to include in the analysis.
19. More specifically, 50% of classes with four or more Internet connections in the classroom used computers frequently, compared with 25% of classes with a single Internet-connected computer.
20. See note no. 7, Becker, Ravitz, and Wong, p. 33.
21. In addition, the extent of students' school-related use of computers outside the classroom was found to vary depending on the teacher's objectives for use of the technology. For example, by far the highest level of student computer use outside of class was reported by teachers whose objective was to help students present information to an audience. Well-above-average school-related use outside of class was also reported by teachers whose objectives were to help students improve writing, communicate with other people, and find out about ideas and information. Students reportedly used computers outside of class less often if their teachers' objectives were to reinforce skills, remediate skills, or help students learn to "work independently" (although it appears that some teachers may have used the phrase "to work independently" to mean that the students worked quietly rather than independently). See note no. 7, Becker, Ravitz, and Wong.
22. See note no. 12, Becker.
23. Findings concerning the difference between professionally engaged teachers and private practice teachers in terms of general pedagogy and computer use practices can be found in Riel, M., and Becker, H. The beliefs, practices, and computer use of teacher leaders. *Teaching, learning and computing, special report.* Irvine, CA: Center for Research on Information Technology and Organizations, University of California, Irvine, 2000. Available online at http://www.crito.uci.edu/TLC.
24. For the complete set of differences between high- and low-achievement-level classes, see snapshot no. 8 at the TLC-1998 Web site at http://www.crito.uci.edu/tlc/html/findings.html.
25. In fact, teachers have received contradictory messages about how they should treat classes with different levels of prior preparation. On one hand, they are urged to individualize their instructional approach to fit students and classes. On the other, they are warned not to channel less demanding activities to their lower-performing classes and students or to limit the presumably more interesting work to their higher achievers.
26. This has been true for many years. See note no. 13, Becker, pp. 289–311.
27. For detailed data on the correlation between school-level SES and teachers' objectives for student computer use, see snapshot no. 7 at the TLC-1998 Web site at http://www.crito.uci.edu/tlc/html/findings.html.
28. Excluding the effects of ethnicity (that are independent of measured socioeconomic factors), and excepting the slight disadvantage of students in southern states, other demographic differences in children's access to home computers—such as for one-parent households or homes in central cities or nonmetropolitan locations—can be accounted for almost entirely by the two variables of income and education.
29. The two variables of income and education combined can explain nearly all the differences in children's access to home computers. For example, among children whose parents had less than a high school education and where family income was under $20,000, only 11% had a

home computer. In contrast, for children in families with more than a $75,000 income and at least one parent with a master's degree, 95% had a computer at home and 80% had Internet access as well. Multiple regression analysis of these two variables produces somewhat larger beta coefficients for family income than for parent education (.36 versus .26). Regarding only the question of whether a child's household has Internet access, given that it has a home computer, neither family income nor parent education were quite as strong predictors as before, but again, income appeared somewhat more important (.20 versus .16).

30. A rough indication of the extent of the inequality resulting from residential segregation by SES is provided in the TLC-1998 survey, which asked school principals if they thought the majority of their students had access to home computers. Only 4% of school principals from schools primarily attended by students from low-income families estimated that a majority of students had access to home computers, compared with 70% of school principals from schools primarily attended by students from professional or managerial families.

31. See note no. 2, McConnaughey and Lader, charts 15a through 15d. Available online at http://www.ntia.doc.gov/ntiahome/net2/charts.html.

32. Only for African-American and Hispanic children in high-income homes with parents having advanced degrees did technology access meet or exceed the level available to non-Hispanic white children from families with similar incomes. See Table 8 at http://www.gse.uci.edu/doehome/deptinfo/faculty/becker/packard/text.html. Similar results were obtained through multiple regression analysis: The negative effects of being African American were a little larger than of being Hispanic (for example, betas for having a computer at home = –.20 for African Americans and –.16 for Hispanics). See Table 9 at the same Web site for the results of the multiple regression.

33. Results from another recent survey indicate that parents' work-related Internet access is the primary determinant of home Internet access among computer-owning households. In that survey, the percentage of parents reporting that they use the Web at work at least every few days was twice as high among Internet-accessing households as among other computer households (41% versus 19%), while neither SES nor parent computer expertise related strongly to Internet access. See Turow, J. *The Internet and the family: The view from parents, the view from the press.* Philadelphia: Annenberg Policy Center, University of Pennsylvania, May 1999. In contrast, the 1998 CPS survey indicated that, for children with a computer at home, Internet access was more likely if parents had more education and income but not if they used the Internet at work. Differences in how work-based Internet use was measured may be responsible for these conflicting findings.

34. The 1998 CPS survey data show that 51% of children ages 6 to 8 had a computer at their home, compared to 60% of adolescents (ages 12 to 17, plus those still in high school at age 18 or 19).

35. According to the 1998 *Roper Youth Report*, adolescent boys were more likely than girls to have their own computer, by 17% to 10%. See Roper Starch Worldwide. Today's kids—especially teens—are wired to the hilt. Press release. New York: Roper Starch Worldwide, November 24, 1999. Results based on in-home, face-to-face interviews with 1,189 children ages 6 to 17. Available online at http://www.roper.com/news/content/news93.htm. However, neither the TLC-1998 nor the Roper study found gender differences in likelihood or frequency of home computer use.

36. According to 1997 CPS data, fewer than one-third of children whose parents were not high school graduates but who had a home computer had one that met the five criteria employed to measure functionality. In contrast, two-thirds of children in computer-present households where at least one parent had a bachelor's degree had a computer that was broadly functional.

37. The effect of parent work use of computers was even greater when breadth of computer use at work was measured. Regression analyses indicate that the number of computer applications each parent used at work was as large a factor as education or family income in predicting whether a home computer would have Internet access or broad functionality or would be one of multiple computers in the home. For the multiple regression analysis, see Table 11 at http://www.gse.uci.edu/doehome/deptinfo/faculty/becker/packard/text.html.

38. Children and adolescents are defined here as schoolchildren ages 6 to 17, plus those still in high school at age 18 or 19. The data for most of the information about home computer access and use come from the U.S. Census Bureau's Current Population Survey of U.S. Households, 1997 and 1998 supplements.

39. See note no. 3, Anderson and Ronnkvist. If K–3 teachers (not surveyed in the TLC-1998 study) had classroom computers in the same proportion as fourth- through sixth-grade elementary teachers, the overall percentage of teachers with at least one computer in their classroom as of 1998 would rise to 59%—slightly higher than the percentage of children's families with a computer at home.

40. An analysis of CPS data indicates that in 1998, the average person-to-computer ratio in children's computer-owning households was 3.9 to 1. In contrast, the TLC-1998 data indicate that in classrooms with any computers at all, the mean student-to-computer ratio was about 14 to 1.

41. Friends' homes and libraries are other important nonschool locations for additional computer use. The Roper-Annenberg survey found that 12% of 6- to 17-year-olds used computers in the homes of friends and relatives during the previous month, and 5% used computers in public libraries. See note no. 33, Turow. The National Assessment of Educational Progress (NAEP) provides quite different information about the proportion of adolescents who use computers at the homes of friends and in libraries, however. The 1996 NAEP study indicated that more than 50% of students used a computer at a friend's house, and more than 60% of students (more than 70% at the 11th grade) used a computer at a library. See Campbell, J.R., Voelkl, K.E., and Donahue, P.L. *NAEP 1996 trends in academic progress.* Report no. NCES 97-985. Washington, DC: National Center for Education Statistics, September 1997. The contrast probably results from the fact that the NAEP question did not specify a time period (such as "during the previous month"), and the differences in response styles between oral interviews (Roper-Annenberg) and questionnaire self-reports (NAEP).

42. In 1998, nearly all home Internet access was provided by relatively slow dial-up modems rather than the high-speed, always-connected networks that are becoming increasingly common at schools and in some residential communities.

43. Although adolescents were still more likely to use the Internet from home, younger children showed the greatest increases in their level of participation during this period. Home Internet use increased from 3% to 10% for children ages 6 to 8, from 12% to 21% for children ages 9 to 11, and from 19% to 29% for children ages 12 to 14. Meanwhile, home Internet use by high-school-age adolescents, although still more widespread than use by younger children, went up by only 5 percentage points, from 27% to 32%. The Roper-Annenberg Foundation study from earlier in 1998 found similar percentages regarding children's home access to the Internet.

44. See note no. 33, Turow, p. 17.

45. The 1998 *Roper Youth Report*, conducted in spring 1998. See Roper Starch Worldwide. Kids favor Internet for homework, chatting and surfing: As in real life, girls are greater virtual socializers. Press release. New York: Roper Starch Worldwide, February 22, 1999. Available online at http://www.roper.com/news/content/news111.htm.

46. The 1998 *Roper Youth Report* found that the proportion of children and teens who used the Internet at least occasionally (in home, at school, or other) was greater than the proportion of adults who did so, even young adults in their twenties. See Roper Starch Worldwide. America is fastest-growing Internet market, as teens lead the way. Press release. New York: Roper Starch Worldwide, April 26, 1999. Available online at http://www.roper.com/news/content/news127.htm. In addition, a panel study of families' home use of the Internet in Pittsburgh (the HomeNet project) found that teenagers used the Internet much more than their parents. See Kraut, R., Mukhopadhyay, T., Szczypula, J., et al. *Communication and information: Alternative uses of the Internet in households.* Pittsburgh: Carnegie Mellon University, July 1997. Available online at http://homenet.andrew.cmu.edu/progress/research.html. See also Kraut, R., Lundmark, V., Kiesler, S., et al. *Why people use the Internet.* Pittsburgh: Carnegie Mellon University, April 1997. Available online at http://homenet.andrew.cmu.edu/progress/research.html.

47. See note no. 46, Roper Starch Worldwide. Among those with online access, 41% of teens ages 13 to 19 reported using online services, compared with 33% of adults ages 30 to 39, 31% of adults ages 20 to 29, and 31% of adults ages 40 to 49. In addition, a panel study of families' home use of the Internet in Pittsburgh (the HomeNet project) found that teenagers used the Internet much more than their parents. See note no. 46, Kraut, Mukhopadhyay, Szczypula, et al.; and Kraut, Lundmark, Kiesler, et al.

48. The HomeNet project also found that recreation and communication activities dominated teens' use of the Internet. Teens were less likely than adults to use the Internet for getting

product information, to purchase items, to read the news, or to view sexually oriented materials. See note no. 46, Kraut, Mukhopadhyay, Szczypula, et al.

49. See Table 12 at http://www.gse.uci.edu/doehome/deptinfo/faculty/becker/packard/text.html for a summary of the results of the standardized multiple regression (beta) coefficients linking each contextual factor with each aspect of home computer use.

50. Note that the percentage of all children who used home computers in these various ways is only half the percentage of children in home-computer-owning households shown in Figure 9 and discussed in the text.

51. For a number of reasons, only one variable was examined for each member of a child's family: the parents' use of computers at work, the child's own use of computers at school, and the child's siblings' use of computers at home. It is likely that the attribution of "impact" belongs as much to the people involved as to the context in which their use of computers is measured.

52. Results from the *Roper Youth Report*, conducted annually, found similar percentages of girls and boys using computers (not only in the home, but also in places such as friends' homes, the library, and part-time work settings) for the first time in 1998. See Roper Starch Worldwide. Kids computer use stabilizes; gender gap disappearing. Press release. New York: Roper Starch Worldwide, February 16, 1999. Available online at http://www.roper.com/roperweb/news/content/news106.htm.

53. Gender differences for some types of home computer use were somewhat larger for adolescents—for example, playing games was reported for 68% of teen boys but only 55% of teen girls.

54. Gender differences in types of home Internet use were generally no greater than two percentage points. Largest differences were in retrieval of news and sports information, with 17% of boys in households with computers, but only 11% of girls likely to use the Web for that purpose.

55. Attitudinal and stylistic differences between girls and boys are explored in Brunner, C., Bennett, D., and Honey, M. Girl games and technological desire. In *From Barbie to Mortal Kombat: Gender and computer games.* J. Cassell and H. Jenkins, eds. Cambridge, MA: MIT Press, 1998.

56. For example, Ford Motor Company provided its 350,000 employees with home computers, color printers, and unlimited access to the Internet for the nominal fee of $5 per month. See Brown, W., and Swoboda, F. Ford offers home PC to every employee; $5-a-month plan reflects firm's focus on Internet. *Washington Post.* February 4, 2000, at A1.

57. Word processing is one of several types of computer applications that have replaced skill practice as the primary focus for middle and high school computer use, apart from teaching about computers. Word processing is by far the most common type of computer assignment, not only in English class, but in almost every other subject as well.