Consortium on Chicago School Research

# Educational Technology:

## Availability and Use in Chicago's Public Schools

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# Executive Summary

Although there are some notable exceptions, technology use in Chicago's public schools is at a rudimentary level. Most schools have not substantially integrated technology into students' coursework and, as a whole, the district lags behind the rest of the country in providing teachers and students with adequate access to computers and the Internet. Although use and availability are not evenly distributed across the district, inequities do not follow differences in student-, teacher-, and school-level demographics. In fact, differences between schools are small. Instead, equity within school buildings appears to be the greater challenge. Most schools have teachers with varying levels of comfort with technology. Increasing and improving technology use therefore, is not only a matter of providing hardware or infrastructure, but of developing schools' capacities for supporting use across all students and teachers.

The limited use of educational technology in CPS schools does not appear to be due to a lack of belief in its benefits. The vast majority of students and teachers believe that the use of computers and the Internet brings academic and occupational advantages. Nonetheless, the availability of technology in Chicago is lower than other urban school systems, particularly in terms of access to the Internet in the classroom. This may partially be a consequence of Chicago's decentralized school system. Although the district has provided funding for some expenditures, individual schools are responsible for the costs of most internal wiring, hardware, and software needs. The tasks of rewiring an old school building, purchasing and installing expensive hardware, and supplying teachers with the training to retool their classrooms may be daunting for many schools.

Once schools are able to provide students and teachers with sufficient and reliable access to technology, a combination of essential supports is needed to propel the use of educational technology forward. In particular, teachers need high quality professional development that leads to a professional community centered around the integration of technology into the curriculum. Principals are critical to this process, especially given Chicago's commitment to local school governance. Where schools have embraced technology, there are leaders committed to this goal. ■

# 1 Public Education: Technology's Final Frontier

Although they lag behind the business world, in recent years, public schools have been thrust into the digital age. According to the National Center for Education Statistics (NCES), in 2000, 98 percent of all public schools and 77 percent of all instructional classrooms had some type of Internet access.[1] This compares to only 50 percent of public schools and 8 percent of classrooms having access in 1995. The introduction of technology to education brings with it both promise and concern. Advocates see the opportunity for a student-centered teaching revolution and students well prepared to excel in an increasingly computerized labor force. Skeptics question whether costly equipment and training will meet these expectations, or only create more expensive typewriters and encyclopedias.

With expectations for technology use and its potential costs continuing to rise, the Consortium on Chicago School Research sought to provide baseline information on educational technology—the use of computers and the Internet for instructional purposes—in Chicago public schools. We address three questions: (1) What are the current levels of technology availability and use? (2) Are availability and use distributed equitably across students, teachers, and schools in the district? and (3) What essential organizational supports are necessary to encourage technology use in schools? We examine these topics by looking at nearly 100,000 responses to the Consortium's biannual survey of teachers and students in 434 of Chicago's schools (see Appendix A for details on surveys, fieldwork, and methods of analysis). Further insight was gained through site visits to schools with model technology programs.

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## BENEFIT, EQUITY, SUPPORT

Advocates of educational technology have advanced two major arguments for the importance of bringing computers and the Internet into the classroom. The first is that technology will improve student achievement by being a catalyst for the development of more student-centered teaching practices. When used appropriately by well-trained teachers, technology can help engage student attention, develop basic skills, and build higher order thinking skills.[2] Second, advocates also argue that technology should be stressed in school because computers have changed the "skill content of employment."[3] The US Department of Labor identified the 54 jobs with the highest growth potential by 2005; only eight do not require some type of technological fluency, none of which currently pays more than twice the minimum wage.[4] Both arguments suggest that students are better served if technology is widely used and available in schools. In this study, we describe the frequency and types of technology use in the Chicago Public Schools (CPS), as well as student and teacher beliefs about technology and its benefits.

Regardless of whether technology's goal is improved educational practice, or a better-prepared workforce, there is general concern that disadvantaged students will not benefit from its use equally. Despite many initiatives to make computing technology available in all schools, studies have found inequities between more and less advantaged schools in national samples. These inequities exist in terms of access and use both at home and at school.

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A study conducted by the Annenberg Public Policy Center at the University of Pennsylvania found that in 2000, 93 percent of families with children aged 2 to 17 with incomes of $75,000 or more owned a home computer. This compares to 40 percent of families with incomes less than $30,000.[5] A study by Henry J. Becker at the University of California at Irvine reported that schools serving poor children are more likely to emphasize remediation and skill building while those serving more affluent student populations tend to focus on analyzing data and presenting information.[6] Authors of *The Connected School: Technology and Learning in High School* (2001) argue, "In schools serving mostly middle-class students, there is an emphasis on teaching students to think and create with technology rather than simply learning from technology. Instruction for middle-class students is geared toward putting the students in control, whereas instruction for low-income students is more likely to put the technology in control." [7]

Similarly, a national study showed that while the frequency of computer use in school does not vary substantially by race/ethnicity or income, there is some evidence that the type of instructional use of computers does.[8] Specifically, African-American, Latino, and low-income students were more likely than white, Asian, and higher income students to use computers for drill and practice than for simulation and application. Another study found that African-American students and Title I participants were about three times more likely to use computers for drills than for simulations.[9] In our examination of equity in Chicago public schools, we look at a range of indicators, including race, income level, and achievement level.

## Schools Need More than Greater Access

As the availability of technology in schools has increased, it has become increasingly clear that access alone will not significantly affect teaching and learning. Larry Cuban found that, in highly resourced Silicon Valley schools, abundant "availability of hard infrastructure...and a growing 'soft' infrastructure...in schools in the late 1990s has not led, as expected, to frequent or extensive teacher use of technologies for tradition-altering classroom instruction."[10] Writing on the challenges of enabling schools to use technology well, Thomas Glennan and Arthur Melmed argue that teachers do not face obstacles learning to use technology, but with "learning to develop and manage the types of learning environments that are facilitated by these technologies."[11] They describe three common requirements for the successful support of teachers as they work to become comfortable in these new environments:

**ADEQUATE TIME**—schools must find ways to make time for teachers to learn new technology, collaborate with other teachers, and organize curriculum. Suggestions include providing teachers with the authority and flexibility to adjust daily instructional schedules and develop curriculum objectives that promote team teaching and interdisciplinary instruction; allow time each day for teachers to meet and plan; and provide time for teachers to reflect on their practice.

**RESPONSIVE ASSISTANCE** to teachers and administrators when they need it. Technology coordinators could fill this role, but according to Becker's 1994 study, tech coordinators only spend about 9 percent of their time actually working with teachers.

**A CLEAR VISION** shared by staff, students and parents of the purpose and educational goals that guide the school's technology program and its role in the classroom.

How do these supports translate to schools and classrooms in Chicago? Through our fieldwork in two model and one emerging school, we look at how the Consortium's framework for school development facilitates the adoption of technology as an indispensable educational tool.■

# 2 How Do Chicago Public Schools Use Educational Technology?

Data for this study come from a survey of all CPS students and teachers conducted by the Consortium on Chicago School Research in the spring of the 2000-01 school year. There was a 75 percent participation rate among schools and, overall, 11,214 teachers and 87,732 students in grades six through ten responded. These subgroups are similar to students and teachers systemwide. Most of our analysis is based on measures created through Rasch techniques. In addition, for some of the analyses, we use three-level hierarchical linear regression models to control for measurement error and to apportion individual- and school-level variance. (Further details about these models can be found in Appendices B and C). To supplement our quantitative analysis, we conducted fieldwork in several schools that exhibited exemplary technology usage.[12] These schools were selected on the basis of their survey responses and expert recommendations.

The student and teacher responses reported here are not based on single items from our surveys, but on measures comprised of multiple items that tap underlying constructs. This approach provides more valid and reliable measurements across respondents and over time. Each measure is based on a continuous scale developed through Rasch analysis. By creating our measures this way, we can determine how respondents with a particular score on a measure most likely answered each question used to create the scale. For some statistical analyses, we use the continuous scale. For displays, we use a three- to five-category characterization of the same measure. The categorical measure creates a substantively meaningful interpretation of the underlying distribution of responses in the continuous measure. To create categories from the continuous measures, we looked for natural clumps of data or logical distinctions between groups.

**In This Chapter We Show:**

- Student and teacher attitudes towards education technology
- The availability of computing resources in CPS schools
- Frequency and type of technology use reported by students and teachers

## What Does Good Technology Use Look Like?

In our visits to our field schools, we observed several exemplary instances of technology being used as a tool to achieve curriculum goals. These examples illustrate the unique benefits technology can provide without becoming the focus of instruction itself.

### Example #1: Collaborative Recycling Project

At Burley Elementary School, two teachers felt that recycling was not only an important issue but that it was also a topic that would provide many different avenues for learning. They developed a project that involved collecting and analyzing data and communicating findings. Students learned how to use digital cameras, edit videos, design web pages, analyze survey data, and create graphs and charts. They also conducted creative and collaborative research on a variety of problems and worked together to devise and communicate their solutions to the school. This is an example of what technology advocates consider transparent technology use. It is used in service to an instructional goal in a way that is natural and endemic rather than as an awkward addition to an old task.

At the beginning of the project, students were broken down into different groups: Video crews were charged with conducting interviews about recycling knowledge and habits. Exposé teams crept into classrooms to obtain garbage and recycling samples and assess recycling practices. After careful analysis, their findings were also recorded on videotape. One student formed his own team to design an educational web page. Another team designed, administered, and analyzed student surveys.

As the project progressed, it became clear to students that each group's data would provide pieces of a comprehensive picture of the school's recycling program. Teams began to share information and support each other's strategies. For example, the survey team decided to analyze their data classroom by classroom so that they could compare their findings with the exposé team to see the relationship between what students claimed to know about recycling and actual behavior. The project evolved further when the exposé team, upon seeing that many members of the school community were not recycling properly, made an educational video demonstrating proper recycling practices.

### Example #2: Weaving Technology into a Traditional Assignment

Students at Hayt Elementary School were studying a novel in which a young person lives through a tornado. As a supplemental activity, the teacher had students study tornados on the Internet. She recommended several good websites that provided explanations of different types of tornadoes and excellent photographs and diagrams. Since the classroom only had three computers, most students read silently during the reading period while six (two per computer) conducted research. Different students used the computers on different days and the teacher paired weaker readers with stronger ones.

### Example #3: Computer Simulations

At Burley, a teacher uses a computer program called "Model It" that helps students simulate environmental problems and propose possible solutions. In one instance, students choose a city and research a particular environmental problem that city faces. They must determine the problem's underlying causes and other factors that affect it and they enter their findings into the program. Model It is able to depict the students' system and allows for adjustments of individual factors. For example, the program shows students what happens if the number of dead fish in a stream rises and how that affects the water quality downstream. In another case, students can use a solar simulator to study passive solar energy by creating their own solar house. They must keep the temperature in their houses between 65 and 80 degrees using the sun as their only source of energy. The simulator shows them how their homes cool off when the sun sets or how it holds heat when skylights are added, different building materials are used, or the seasons change.

Although creating simulations is perhaps one of the chief advantages for using technology in education, few teachers in our survey reported using them. This particular teacher related the impact the program makes on her students' understanding of a particular problem, "[With traditional methods] they can do it and a lot of times they'll get the results and they'll have a table or they'll have graphs, but they really won't quite understand it, but if you put it onto a simulation or onto the computer and you let them actually see how...things go together, they really do get it."

### Example #4: EZine

Northwestern University's Collaboratory began an electronic magazine called *EZine* at Hayt by training several teachers and five sixth-grade students. Northwestern also provided a $700 digital camera and $500 worth of software so that the magazine could have streaming video. Students select topics, write articles, edit video, and design the layout of the magazine, often coming in on their own time before and after school. The computer teacher provides technical assistance and another teacher provides editorial support. The project began with a small group of students and now these students are training others.

# STUDENT RESPONSES

## Beliefs about Importance and Reports of Availability

In general, students are enthusiastic about using technology to learn. Three quarters (76 percent) agreed that learning how to use computers and the Internet helps them perform better in their classes, makes classwork more fun, and will help them find employment. Students also have positive reports about the availability of technology at school; the majority (65 percent) felt that their schools have enough computers and that they can usually find an available one to use for homework. It is important to note, however, that more than a third of students (35 percent) report insufficient computer availability at school, suggesting that certain schools or groups of students may have inadequate access to technology resources. (Equity across schools and among teachers and students is discussed in detail in Chapter 3.)

## Use of Technology in School

We measure student technology use in terms of intensity, which captures the frequency and breadth of use, both at school (for specific tasks) and for core academic subjects. For each, intensity is considered to be the frequent use of technology across a wide variety of activities or courses.

In the first measure, students reported how frequently (during this school year) they used a computer at school to perform a number of tasks, including word processing, Internet research, and analyzing/graphing data. Based on these responses, we find that only 19 percent of students use technology intensively at school (see Figure 1). These students performed common tasks such as word processing or Internet research almost every day and other tasks, such as analyzing/graphing data or creating presentations, about once a week. The typical CPS student is a moderate (38 percent) or limited (25 percent) user of technology at school. Moderate technology users perform basic tasks once or twice a week and activities such as analyzing/graphing data once or twice a semester. Limited technology users are only exposed to basic tasks (word processing and Internet research) and do these less frequently (from once or twice a semester to once or twice a month). Another 17 percent of students never use technology at school for any of the activities listed.

*Figure 1: Students' Use of Technology in School*

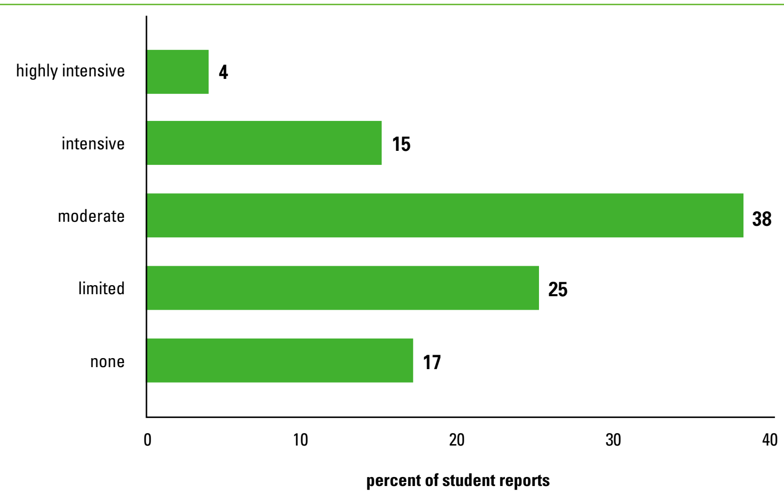


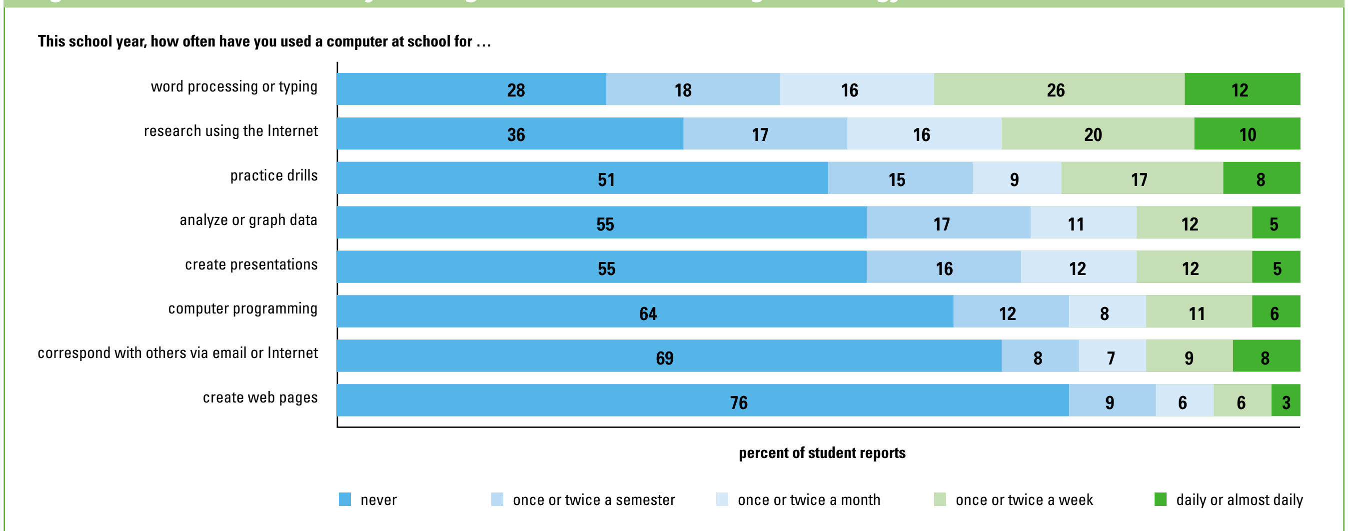
Figure 2 shows the individual items that comprise the Student Use of Technology measure. Those items at the bottom of the graph (e.g., creating web pages, email, computer programming ) are done the least frequently. Students perform word processing most, with over 70 percent reporting that they do this activity at least once a semester. Internet research is another relatively common task, 64 percent of students reported that they access the web at least once during the school year. Fewer than half of students, 45 percent, use technology for analyzing or graphing data. Most students rarely engage in computer programming and creating web pages.

## Does Use Vary by Subject?

The second measure of student use of technology examines the frequency of technology use across several or all of the core academic subject areas: English/reading, social studies/history, math, and science. One-quarter of students use technology at least weekly for all of their core courses. Slightly more than a third (36 percent) do not use technology for any core academic classes. The balance (40 percent) use technology at least weekly for English/reading, and at least monthly for all the other core academic courses.

Students are most likely to report using a computer to work on an assignment for English/reading, with 57 percent reporting that they complete at least some of their assignments using technology. Students were least likely to use technology in math class; only 38 percent reported using technology for at least some math assignments. This means that 62 percent, or nearly two-thirds of CPS students, never used technology for a math assignment during the 2000-01 school year.

*Figure 2: How Are Elementary and High School Students Using Technology?*



## How Do Students Use Technology at Home?

More than half of students surveyed report having a computer at home (60 percent) and 41 percent report having Internet access at home. (There is no significant difference between elementary and high school students on this measure). Of those students who have a computer at home, 63 percent report using it almost every day. Another 20 percent say they use it once or twice a week. Those students who have a computer at home with Internet access are even more likely to use it frequently—72 percent use it almost every day and 18 percent use it once or twice a week).

Students are also more likely to use a computer at home than in their regular classroom. Forty-two percent of students report that they never used a computer in their classroom in the 2000-01 school year. This compares to only 31 percent saying they never used a computer at home. Furthermore, only 12 percent of students say they used a computer daily in their regular classroom, but 43 percent of students say they used their home computer daily.

Given the frequency with which students use their home computers, it may seem that home access gives students an academic advantage. We do not know, however, whether students use computers at home for academic purposes or for entertainment (e.g., instant messaging and computer games) and so the extent of this benefit is not yet known.

# TEACHER RESPONSES

## Beliefs about Importance and Reports of Availability

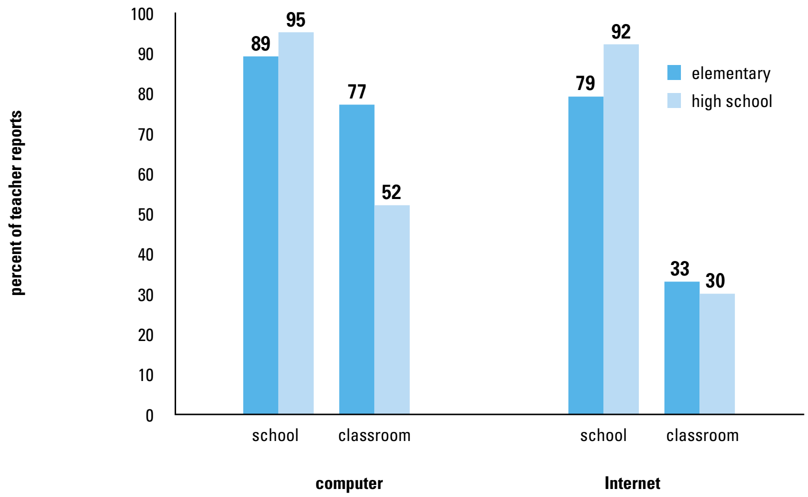
Like students, most teachers have positive attitudes about technology's potential to enhance students' educational experiences. They believe that it can play a role in strengthening students academically, that it can prepare students for the work force, and that technology can help promote student engagement in the classroom and project-based learning. These findings suggest that those who seek greater technology integration in Chicago classrooms do not face a skeptical teachers corps.

Nearly all teachers agree or strongly agree that technology can contribute to typical educational objectives such as engaging students in the classroom, developing critical thinking skills, and preparing students for future jobs. One item on the survey had a somewhat lower level of agreement, however. Only three-quarters of teachers (versus about 90 percent for the other items) endorsed the statement, "Computing technology should be used to raise standardized test scores." Although the reasons for fewer endorsements of this item are not clear from the survey data, one possibility is that some teachers are uneasy about using computers for particular activities, such as test prep programs, that focus on raising test scores. Several teachers in our field study schools expressed such concerns. One admitted that while there was potential value in some drill and practice programs, there was not sufficient value in these activities to warrant the exclusive use of drill software: "I see the computer as a tool as opposed to a teacher....There's some valuable stuff out there...but I don't think that a student could learn enough from that to take up a workstation."

Although nearly all teachers believe that technology is an important educational tool, a substantial number lack access to critical technological resources. Nearly all teachers have access to a computer and the Internet somewhere in the school, but only a third of teachers have Internet access in their classrooms (see Figure 3). This indicates that most teachers need to go to a computer lab, library, or another office to use email and the Internet. In addition, a large difference in access exists between elementary and high school teachers. At the time of data collection, more than three quarters of elementary teachers (77 percent) had a computer available to them in their classrooms compared to only 52 percent of high school teachers.

*Figure 3:*

*Teacher Access to Computers and the Internet*




## How Do Teachers Use Technology for Professional Work?

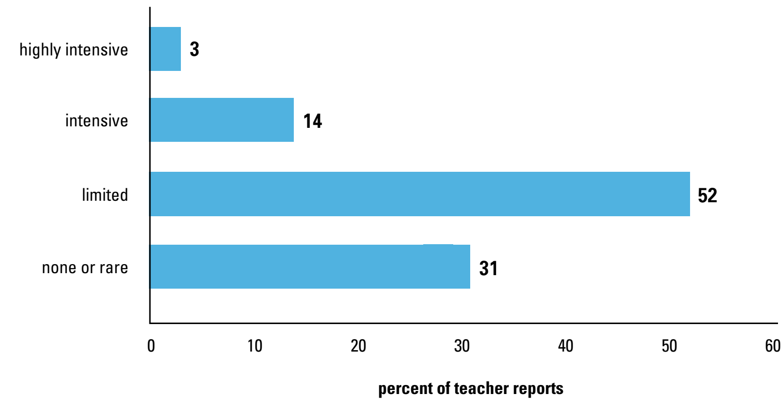
Research indicates that teachers are generally extraordinarily pressed for time and are often quite isolated from their peers. Under optimal conditions, technology could make administrative tasks less time consuming, communication more fluid, and information sharing more efficient. In addition, it is difficult to "teach" if you cannot or do not "do." In other words, in order for students to become computer literate, teachers themselves should be proficient enough with technology to feel comfortable integrating it into their classroom lessons.

### For Teaching and Lesson Planning

To investigate the extent to which teachers are using technology to prepare classroom lessons, we asked a series of questions about teachers' typical use of technology, such as preparing instructional materials, doing research on the Internet, and preparing multimedia presentations (see Figure 4). We find that 31 percent of teachers use technology either minimally or not at all. At most, they use technology once a semester to create instructional materials or gather information for planning lessons, but do not use it for other activities. Slightly more than half, or 52 percent, use technology in a manner we characterize as limited, meaning that teachers use technology for more basic tasks up to once a week, access model lesson plans and best practices for teaching up to once or twice a month, and create multimedia presentations occasionally. Although most teachers either do not use technology at all or use it in a limited way, there is a small minority of intensive technology users (17 percent). These teachers regularly use technology for basic tasks; access information, such as best practices, at least weekly; and create multimedia presentations weekly or daily.

*Figure 4:*

*Level of Teachers' Professional Use of Technology*




As suggested above, teachers' most common use of technology centers on creating instructional materials such as handouts or tests. Eighty-two percent have used technology in some way for this purpose. About the same proportion use the Internet to access information for lessons (79 percent). Most teachers have also accessed model lesson plans and research and best practices for teaching (62 percent and 65 percent, respectively). Less common tasks are accessing the CPS Intranet (51 percent of teachers had done so) and creating multimedia presentations for the classroom (37 percent).

## For Administrative Tasks

An important indicator of teachers' comfort with technology is their ability to perform administrative tasks efficiently. The faster teachers can take care of day-to-day business, the more time and energy they have to devote to student learning. We asked teachers about their use of technology to communicate, analyze data, and keep records. We find that half of teachers never use technology to analyze student data or do record keeping. More than half (61 percent) never email other teachers and most (87 percent) never email students. However, one-quarter of teachers do use computers to analyze student data from once to twice a week to daily.

One factor that may explain low levels of technology use for administrative purposes is that many schools have not yet adopted software and installed the necessary computers and computer networks to enable teachers to track attendance and grades. In addition, when such equipment is available, this software is sometimes not compatible with CPS systems and complications with installation can make them difficult to manage. While this may be surprising given the extent of technology use for record keeping and communication in other professions, it is clear that CPS schools are well behind the business world when it comes to tapping network computing's possibilities. Evidence of this lies in the reality that CPS does not provide students and teachers with email accounts. Many students and teachers have free email accounts, such as through Yahoo!, but these services are often swamped beyond capacity during school time. In one case study school, teachers and students had to access their email via the Yahoo! Sweden website because Yahoo! will only accept a certain number of connections from within a particular network.

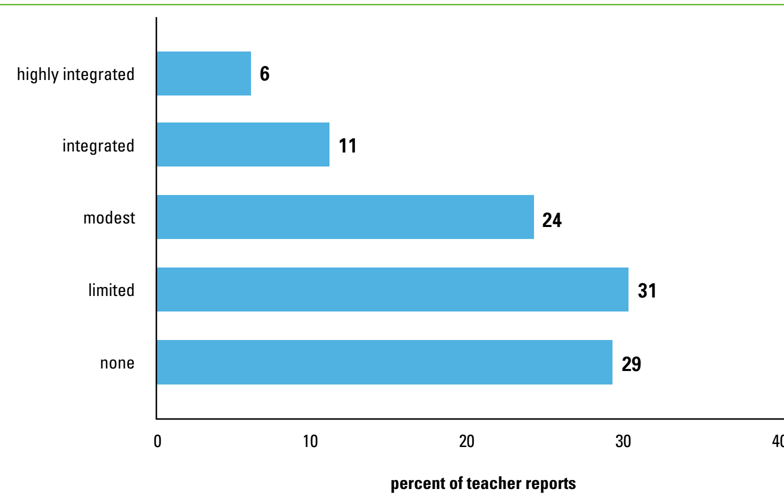
## Teachers' Assignment of Technology

Teacher assignment of technology is perhaps the most important determinant of whether students use technology at school. If teachers assign lessons that integrate technology, students will use it. We constructed a measure of technology integration into classroom lessons that uses the same list of activities presented to students (e.g., word processing, analyzing/graphing data, research on the Internet). Because the scope of the questions differ, however, and we only have data from students in grades six through ten (compared to teachers from all grades), the measures are not directly comparable.[13]

We find that only 17 percent of teachers practice an "integrated" or "highly integrated" approach to lesson planning (see Figure 5). We characterize integrated teachers (11 percent) as assigning basic tasks (such as word processing and Internet research) weekly, and more advanced tasks, such as analyzing/graphing data or creating presentations, at least once per semester. Highly integrated teachers, 6 percent, assign uncommon tasks (i.e., demonstrations, creating web pages or computer programming) as well as assigning students to use computers in more common ways. More than half of teachers, or 55 percent, assign technology in modest or limited ways. These teachers assigned word processing and Internet research from once or twice a semester to once or twice a month. Those characterized as modest integrators also assigned more complex tasks such as analyzing/graphing data as much as once or twice a month. Limited teachers did not assign any tasks other than word processing or Internet searching. Finally, 29 percent, or nearly a third, do not assign technology at all.[14]

Teacher assignment of technology parallels student reports of the ways they use technology. Word processing and Internet research were the most common activities listed by both teachers and students. More than half (50 to 60 percent) of teachers assigned these activities at least once a semester. The most infrequent activities were corresponding with others via the Internet or email, computer programming, and creating web pages, which only 10 to 20 percent of teachers assigned at least once a semester.

*Figure 5: Level of Teacher Integration of Technology into Student Assignments*



## HOW DOES CHICAGO COMPARE NATIONALLY?

In 1999, the National Center for Education Statistics (NCES) surveyed public school teachers across the country on their use of computers and the Internet.[15] In order to compare Chicago to this national sample, we included several items from the NCES survey in the Consortium's spring 2001 survey.

Given the fast growth of technology in the last few years, one might expect that 2001 CPS data should surpass the 1999 NCES figures. Instead, technology access and use reported by CPS teachers in 2001 either equaled or lagged behind levels reported by NCES teachers two years earlier. Most notable is the low level of Internet availability inside classrooms. Only a third of CPS teachers reported Internet access in their classrooms, compared to 60 percent of elementary and 72 percent of high school teachers in the NCES survey two years before (see Table 1). In addition, three quarters of NCES high school teachers reported having a computer in their classrooms compared to only half of CPS high school teachers. In contrast, home Internet access was higher for CPS teachers. This may be due to the growth in the availability of low cost Internet service providers since 1999. In general, CPS teachers assigned most computer tasks at rates similar to those reported by NCES teachers (see Table 2), with the exception of assignment of demonstration/simulations, which CPS teachers report doing less. CPS teachers were also slightly less likely to ask students to correspond via email. These differences may partly reflect the hardware availability issues described.

*Table 1: Availability of Technology: CPS Schools Compared to National Sample*

| | Percent of teachers reporting | | | | |
|---|---|---|---|---|---|
| | CPS 2001 Elementary | CPS 2001 High School | NCES 1999 Elementary | NCES 1999 High School | NCES 1999 City Sample Elem and HS |
| Computer in classroom | 77 | 52 | 89 | 75 | 80 |
| Internet in your classroom | 33 | 30 | 60 | 72 | 60 |
| Computer elsewhere in school | 89 | 95 | 93 | 99 | 94 |
| Internet elsewhere in school | 79 | 92 | 87 | 96 | 90 |
| | CPS 2001 ELEMENTARY & HS | | NCES 1999 ELEMENTARY & HS | | NCES 1999 City Sample ELEM & HS |
| Computer at home | 85 | | 82 | | 79 |
| Internet at home | 75 | | 63 | | 62 |

**Note:** *NCES defines "city" as the central city of a Metropolitan Statistical Area (MSA). Besides Chicago, examples of other Illinois cities are Peoria and Rockford.*

*Table 2: Teacher Use of Technology: CPS Schools Compared to National Sample*

| | Percent of teachers assigning computers/Internet for the following (at all): | | |
|---|---|---|---|
| | CPS | NCES full sample | NCES city |
| Practice drills | 50 | 50 | 49 |
| Create presentations | 40 | 43 | 44 |
| Demonstrations/simulations | 29 | 39 | 39 |
| Research using Internet | 52 | 51 | 49 |
| Correspond via email | 18 | 23 | 25 |

One group of questions that asked about the barriers that affected teachers' use of technology produced very similar results for both samples (see Table 3). Although two years apart, in both groups, around 80 percent of teachers cited lack of release time, lack of time for students to use computers, and not having enough computers as barriers. Lack of support for integrating technology into the curriculum was also a barrier for a majority of teachers (79 percent for CPS and 68 percent for NCES). In addition, finding appropriate software was a barrier for over 70 percent of teachers. Lack of support from school administration was a barrier for over a third of teachers in both samples.

*Table 3: Barriers to Technology Use: Chicago Compared to National Sample*

| | Percent of teachers identifying items as small, moderate, or great barriers to technology use | |
|---|---|---|
| | CPS 2001 | NCES 1999 |
| Lack of release time for teachers to learn/practice/plan ways to use computers or the Internet | 85 | 82 |
| Lack of time in schedule for students to use computers in class | 82 | 80 |
| Not enough computers | 83 | 78 |
| Difficulty in selecting appropriate instructional software* | 75 | 71 |
| Lack of principal support* | 36 | 43 |
| Lack of appropriate professional development on how to integrate computing technology into curriculum* | 79 | 68 |

**These items are similar but not identical to NCES items.*

## SUMMARY

Technology has not become an integral part of most students' learning experiences in the most central aspects of the curriculum. Most CPS students and teachers use technology infrequently and for a narrow range of activities. The typical student in Chicago uses computers for word processing and Internet searches, but very seldom for any other purpose. Although these uses do have some value, they represent a small piece of technology's potential as an educational tool. Furthermore, about 17 percent of students never use technology for any reason at school and 36 percent report no assignment of technology use in their core classes. It is difficult to see how these students in particular will succeed in higher education and in an increasingly computerized economy without some level of school-based computer literacy.

Computer use among teachers mirrors that of students. The typical CPS teacher uses technology either not at all or in a limited way to prepare classroom lessons and perform administrative tasks, and integrates technology into classroom lessons either modestly or in a limited way. About a third of teachers never or rarely use technology themselves. Levels of teacher integration of technology into classroom assignments are higher than levels of teacher professional use. About four in ten teachers assign classroom lessons that integrate technology in more than a limited way.

The modest use of technology by students and teachers cannot be attributed to a lack of belief in technology's benefits. The vast majority of students and teachers believe learning technology has educational and occupational benefits. Most teachers, for example, agree that technology should be used to strengthen students' basic skills, improve standardized test scores, and develop critical thinking. One obvious obstacle to higher technology use is the limited availability of hardware and Internet access in the classroom. CPS lags behind other US cities in providing computers and Internet access, especially at the classroom level. This is particularly true in high schools. Other potential obstacles such as lack of professional development and technical support are discussed later in this report.■

# 3 The Digital Divide: Equity Analysis of Technology Availability and Use

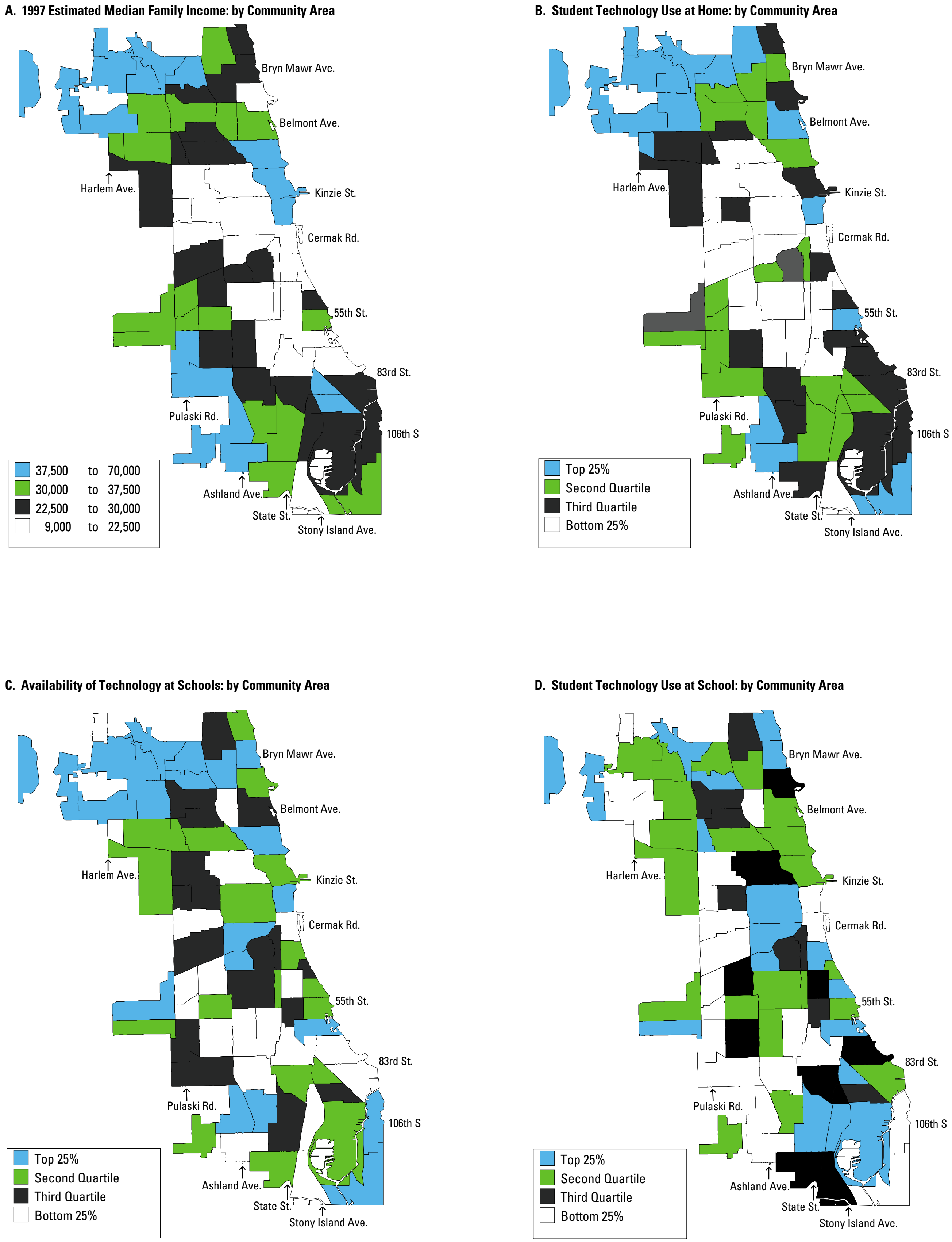
National studies have shown that a "digital divide" exists among the information rich and the information poor.[16] Access to technology did increase dramatically over the course of the 1990s, but it was not distributed equitably—computer and Internet users are more likely to be white or Asian and from households with higher income levels and levels of education. Americans who are non-Asian minorities, have lower income and education levels, or live in central city areas use computers and the Internet less frequently.[17]

Chicago is no exception to these national trends. Maps A and B in Figure 6 show that CPS students who live in neighborhoods with high median incomes tend to use computers frequently at home. Conversely, students in neighborhoods with low median incomes tend to use computers infrequently at home. The census-tract-level correlation between median income and students' use of technology at home is quite high (+0.73), indicating a strong relationship between the two. Although the price of home computers, software, and Internet access has fallen sharply in the last ten years, their cost continues to be prohibitively high for many lower income Chicago families.

**In This Chapter We Show:**

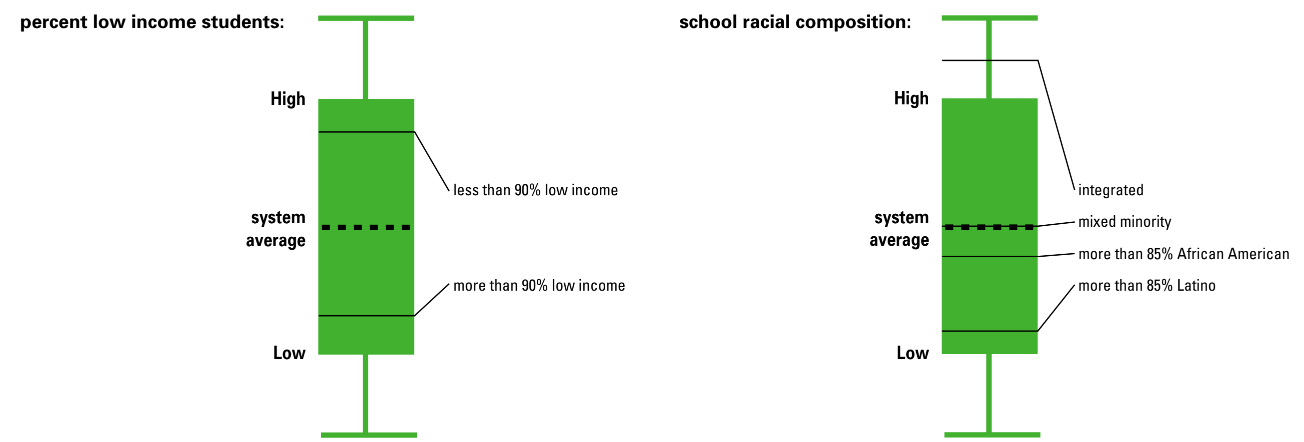
- Student use of technology at home, by school, race, and income level
- Student access to and use of technology at school, by demographic characteristics and the characteristics of schools
- Teacher access to and use of technology at school, by demographic characteristics and the characteristics of schools

*Figure 6: Digital Divide in Student Technology Use at Home Not Replicated in Schools*



School comparisons also show a divide in the extent to which CPS students use computers at home (see Figure 7). Elementary students who attend schools that do not serve primarily low-income students tend to use computers at home much more than students at predominantly low-income schools.[18] This also holds true when we look at the racial composition of schools. Students at integrated elementary schools are much more likely to use computers at home than students who attend schools whose enrollment is primarily non-Asian minority. Similar differences exist among high schools.

*Figure 7: Digital Divide in Student Use of Technology at Home: Elementary Reports*




## How to Interpret Equity Displays

Equity displays show the average technology use or availability for each group against the range of responses across the system. The dashed line indicates the system average. Surrounding the system average is a box that indicates a range of two standard deviations around the mean (one above the system average and one below); two-thirds of all students/teachers/schools fall within the range of the box for that measure. Spreading out from the box are lines that end two standard deviations from the mean. These represent extreme values (approximately the 2nd and 98th percentiles).

These figures allow us to easily see how groups of students, teachers, and schools differ from each other compared to the total range of responses. **It is important to note that that there are many more differences in computer use and availability among students and teachers in the same school than between schools.** (Student measures have about three times more variance within schools than between them; teacher measures have about ten times more variance.)

## DO SCHOOLS MAGNIFY THE DIVIDE?

Our findings confirm that a digital divide does exist in Chicago students' use of computers and the Internet at home. In general, however, schools do not seem to be magnifying the problem substantially. Where disparities along the line of the digital divide do exist, they are small. This is not to say that students and teachers in all schools have the same levels of technology availability, or that they are using it to an equal degree. They are not. However, the differences in school availability and use are not strongly related to the racial composition or family income levels of students in the school. On the other hand, although schools are not exacerbating the digital divide, they are not compensating for substantial inequity in home use.

### Technology Availability in Schools Not Related to Community Income Level

Comparison of Maps A and C in Figure 6 shows that the availability of technology in elementary schools is not strongly related to the median income of households in the community, as was found in home use (Map B). School availability is high in some high-income neighborhoods (as in the Northwest area of the city), but it is high in many lower income neighborhoods as well. The tract-level correlation between median income and student reports of school availability is low (+0.11), indicating that there is not a strong relation between the two. Furthermore, students from more affluent neighborhoods do not report more use of technology at school than students from less advantaged ones (see Maps A and D). In fact, the association, though weak, goes in the opposite direction (-0.14).

### Are Schools Bridging the Digital Divide?

Although schools may not be exacerbating the digital divide that exists in home use, they are not helping students overcome it. In Chapter 2 we show that, on average, technology use in CPS schools is at a low level. In most cases, this is unlikely to compensate for the substantial difference in students' home use, particularly since students report using technology much more at home than at school (see page 9). At the same time, we do not know how students are using computers at home; our measure of school use takes into account the types of activities students are using technology for, our measure of home use does not. If students' computer use at home consists of mostly computer games and instant messaging, then a disparity between home and school use may be of little educational importance. On the other hand, if students are using their computers at home for educational purposes, they may have a substantial advantage over their classmates. At this time, any definitive comparison of in home versus school use is beyond the capacity of our data.

## THE EQUITY OF COMPUTER AVAILABILITY AND USE AMONG STUDENTS

We analyzed differences in computer access and use in school among different groups of students and among different types of schools.[19] Originally, we looked at elementary and high schools separately. However, because differences between types of students (i.e., by family income, race/ethnicity and achievement) were similar at both levels, we combine them for our displays and discussion. We present school differences separately for elementary and high schools because different patterns emerged based on school characteristics.

Among students, we examined whether differences exist in terms of their:

- Race/ethnicity
- Gender
- Economic status[20]
- Achievement level[21]
- Parent level of education
- Grade level

Among schools, we considered whether there were differences in student computer use and access by:

- Racial/ethnic composition of the school
- Percent of students classified as low income (over 90 percent compared to under 90 percent)
- Average student achievement levels

### Are Certain Students Using Technology More than Others?

***See pages 27 to 29 for equity displays on the measures described below.***

Given the national digital divide and our findings regarding home use in Chicago, we expected to find substantial differences in school availability and use based on students' race/ethnicity, parent level of education, and income. Contrary to our expectations, differences were modest and not consistently lower for groups with less technology use at home.[22] Only very small differences were found in school availability and use based on students' economic status or their race/ethnicity. One indicator of the divide was slightly evident—students with the most educated parents reported using technology at school slightly more than students whose parents did not go to college. Again, these differences were small.

There is some evidence that Chicago schools may be using technology in compensatory education programs for students who are low achieving, limited-English-proficient, or have a disability. The lowest achieving CPS students report the most technology use in school. In addition, students in bilingual and special education programs report using technology slightly more than other students. These slight differences may be due to measurement effects or a response bias; our data cannot be conclusive on this. Many more low achieving students did not answer technology questions on our survey than high achieving students. Those that did choose to answer questions on technology may tend to be those using technology more.[23] We were also concerned that these students may be reporting higher use of technology but doing mostly low-level tasks such as word processing and Internet searches. We found, however, that they reported doing more of all types of tasks, including more sophisticated ones such as designing web pages and analyzing data. It is possible that because special education and bilingual teachers tend to have more flexibility and smaller class sizes, it might be easier for them to integrate technology into their lessons. It is also possible that students who are low achieving, have a disability, or are limited-English proficient are allowed more school time to work on technology assignments and so report using technology more frequently in school. Nonetheless, several teachers at our case study schools highlighted the benefits of technology for reaching students with disabilities.[24]

One might expect that high school students would report greater technology use because they are those most in need of job and post-secondary readiness skills. This is not the case for CPS, however. The oldest students that we sampled, those in 10th grade, reported using technology less than students in grades six through nine. Technology use may be greater in grades 11 and 12, but we have no evidence that this is the case. We performed additional analysis to discern any gender differences among CPS students, as other studies have found that girls tend to be less intensive technology users.[25] We found no difference; boys and girls report similar levels of both availability and use of technology.

## Do Students at Certain Types of Schools Use Technology More?

***See pages 30 and 31 for equity displays on the measures described below.***

Although we do not see any substantial differences between students' access to and use of technology at school by student characteristics, it is possible that students at certain types of schools are using technology more or less than others. This may be due to some structural characteristic of the school, such as school leadership, community support, or the school's facilities, or to the concentration of certain types of students in the school (e.g., over 90 percent low income or less than 15 percent reading at norms). Therefore, we compared schools with different characteristics, including racial/ethnic composition, percent of students classified as low income, and average achievement levels among students.

### Elementary Schools

Surprising contradictions arise at the elementary level when looking at differences in technology availability and use by school type.[26] Schools whose enrollments are predominantly African American, schools with less than 20 percent of students at national norms, and schools that serve predominantly low-income students show below average computer availability. At the same time, these schools show above average use. Conversely, integrated schools, schools with the highest average achievement levels, and those that do not serve predominantly low-income students show greater than average computer availability and less-than-average use. Almost all these differences can be attributed entirely to the clustering of certain types of students in certain types of schools rather than any structural characteristic of the school. Small differences in computer use and availability between types of students are magnified when they are clustered in certain schools. After controlling for the characteristics of the students in schools, only one of these effects remains statistically significant: schools with predominantly African-American enrollments show lower levels of student access to computers than other types of schools.

## High Schools

On the high school level, there were no significant differences in equity based on the percentage of low-income students a school served. There were two significant differences based on a school's racial composition, however. First, high schools with predominantly Latino enrollments showed lower levels of student access to computers than others.[27] Assuming that students at predominantly Latino high schools mirror their elementary school counterparts, it is possible that they are using computers more in school because they have less access at home (see Figure 7 on page 21). Second, integrated high schools showed higher technology use than other types of high schools. Differences in access for Latino high schools disappear when we control for student characteristics, indicating these differences are due to characteristics of students and not schools. Integrated schools continue to show higher student use, however, indicating that these schools are different beyond the students that they serve.

The largest differences in student access to technology occur among high schools with different levels of student achievement. Students in selective admissions high schools report much greater access in school than those at non-selective schools. Selective admissions schools clearly have substantially more computing resources available to students than other types of schools. At the same time, however, students' reports of technology use at these schools were not significantly different from those at neighborhood and probation high schools. Indeed, although students in probation high schools report the least access to technology in school, their reports of use are not far behind those of selective high schools. Although this pattern is similar to that for the elementary schools, it is particularly surprising given the disparity in students' access to technology between probation and selective admissions high schools. Unlike elementary schools, inequity in computer availability remains after controlling for the characteristics of students. Also, the difference between selective admissions and other types of high schools in students' computer use grows after controlling for student characteristics.

### More about Selective Admissions High Schools

Data reported here indicate that selective admissions high schools are exceptional in student and teacher reports of computer availability and use. These high schools were established to attract and retain the most academically qualified students in the system. Enrollment is academically selective and is not primarily made up from students living in the neighborhood immediately surrounding the school. About 11 percent of CPS high school students enrolled in a selective admissions school in the spring of 2001.

Several selective admissions high schools were created after 1997, and were built or remodeled with computing technology incorporated into their designs. The following eight are considered selective admissions high schools:

Chicago High School for Agricultural Sciences
Chicago Military Academy
Gwendolyn Brooks College Preparatory Academy
Jones College Preparatory High School
Lane Technical High School
Lindblom College Preparatory High School
Northside College Preparatory High School
Whitney M. Young Magnet High School

## EQUITY OF COMPUTER AVAILABILITY AND USE AMONG TEACHERS

Another important gauge of technology equity in CPS schools is the distribution and use of technology among teachers. Clearly, if some teachers are using technology more than others, some students will be placed at a disadvantage. As with other tools of instruction, teachers mediate students' exposure to technology. If certain types of teachers have less access or are less likely to use it, this will have implications for human resource development.

We examine equity among teachers in the same way as for students—Are certain types of teachers using technology more than others? Are teachers in certain types of schools reporting greater or less use? Three measures were established: teachers' reports of computer availability, use for their own work, and assignment of technology to students. Each was compared among groups of teachers with different individual characteristics, including:

- years of teaching experience
- race/ethnicity
- gender
- level of education
- subject area (self-contained classroom, English, mathematics, etc.)
- grade

As the patterns in computer use based on demographic characteristics were very similar among elementary and high school teachers, we combined them for our displays and discussion, unless explicitly stated. We present elementary and high school comparisons separately for our analysis of teachers in types of schools, as they showed very different patterns. As with the student measures, school comparisons are based on the schools' racial/ethnic composition, percent low income, and average student achievement level.

## Are Certain Teachers Using Technology More than Others?

***See pages 32 and 33 for equity displays on the measures described below.***

### Experience and Education

It is often assumed that newer teachers and those with advanced degrees are more likely to use technology for their own work. We do find that higher levels of education are associated with more technology use; teachers with master's degrees are somewhat more likely to use technology for their own work and to integrate it into classroom lessons than their colleagues who do not have master's degrees. We find a more complicated pattern in technology use when we look at teachers' level of experience.

Teachers with fewer years' experience report lower levels of computer availability and integration of technology into lessons than teachers with more experience. On the other hand, newer teachers report higher levels of technology use for their own work. This suggests that although new teachers are perhaps more comfortable with technology as a productivity tool for their own work, their lack of adequate access to computer resources may limit their ability to integrate it in lessons. New teachers may also be working to master classroom management and curriculum before bringing technology to their students, especially if educational technology was not a focus of their teacher training.[28] These findings also suggest that professional use of technology, while an important indicator of teachers' comfort with computers, is not sufficient to ensure that technology will be integrated into the classroom. (See Chapter 4 for further discussion.)

### Subject and Grade

Teachers' access to and use of technology are somewhat related to the subject and grade they teach. Not surprisingly, vocational/business/technology teachers report the highest levels of availability and use. Junior high teachers (grades seven and eight) report the highest levels of computer availability. These and high school teachers report more professional use and assignment of technology than primary grade teachers.

### Gender and Race

We found no substantial gender or race/ethnicity differences in teachers' reports of availability, professional use, or assignment. White teachers report somewhat less assignment of technology to students than other teachers. Male teachers report slightly more assignment of technology, but this disappears when we control for other teacher and school characteristics.

## Do Teachers at Certain Types of Schools Use Technology More?

***See pages 34 and 35 for equity displays on the measures described below.***

### Elementary Schools

Like students, teachers in schools with predominantly African-American and low-achieving enrollments report lower availability than teachers in integrated and higher achieving schools. Teachers in probation schools are the least likely to assign technology to their students.[29] There are only slight differences between schools based on the percentage of low-income students served. Only two school-level differences remain significant after controlling for individual teacher characteristics. First, higher achieving elementary schools continue to show greater availability and assignment of technology beyond the individual characteristics of their teachers. Second, schools whose students are predominantly African-American continue to show lower levels of computer availability for teachers than other types of schools.

### High Schools

High school teacher reports show greater inequities by school achievement level and percent low income than reports from their elementary school colleagues. The most striking high school finding is the tremendous gap between selective admissions and probation high schools. Although a similar pattern was found in student reports, the differences in teacher reports are even more striking. In all three measures, selective schools show levels of teacher access and use far above the mean while probation schools are far below.

Mirroring findings among high school students, teachers' reports of availability, use, and assignment are lowest in high poverty schools. However, although students in predominantly Latino schools reported the lowest availability, teachers in these schools report the highest availability. Latino schools continue to show the lowest levels of teacher assignment of technology, concurring with student reports.

Many of the differences across schools can be explained by the characteristics of teachers. After controlling for individual characteristics, only one school-level difference remains significant. Selective high schools show much greater availability, teacher professional use, and assignment of technology than other types schools regardless of the characteristics of their teachers.

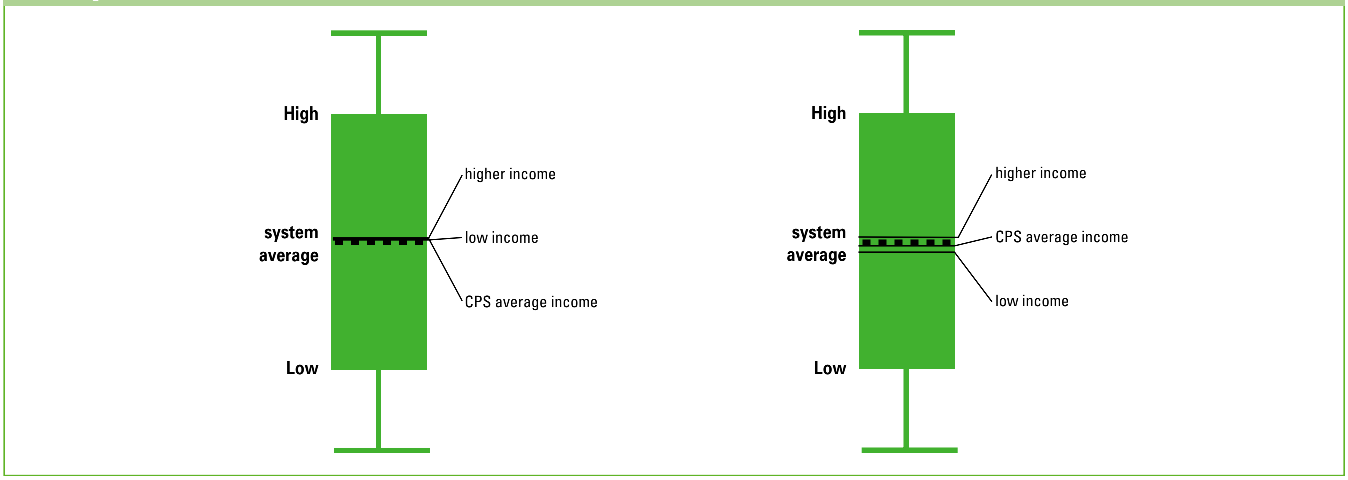
## SUMMARY

A digital divide does exist among CPS students in the degree to which they use computing technology at home. This divide is largely not replicated in Chicago's public schools. There are some notable exceptions, however. Elementary schools that serve primarily African-American students show less availability of computing technology for students and teachers than other elementary schools. The biggest exceptions, however, exist among high schools; selective admissions high schools have substantially more computing technology available to students and teachers than other high schools, especially compared to those on probation.■

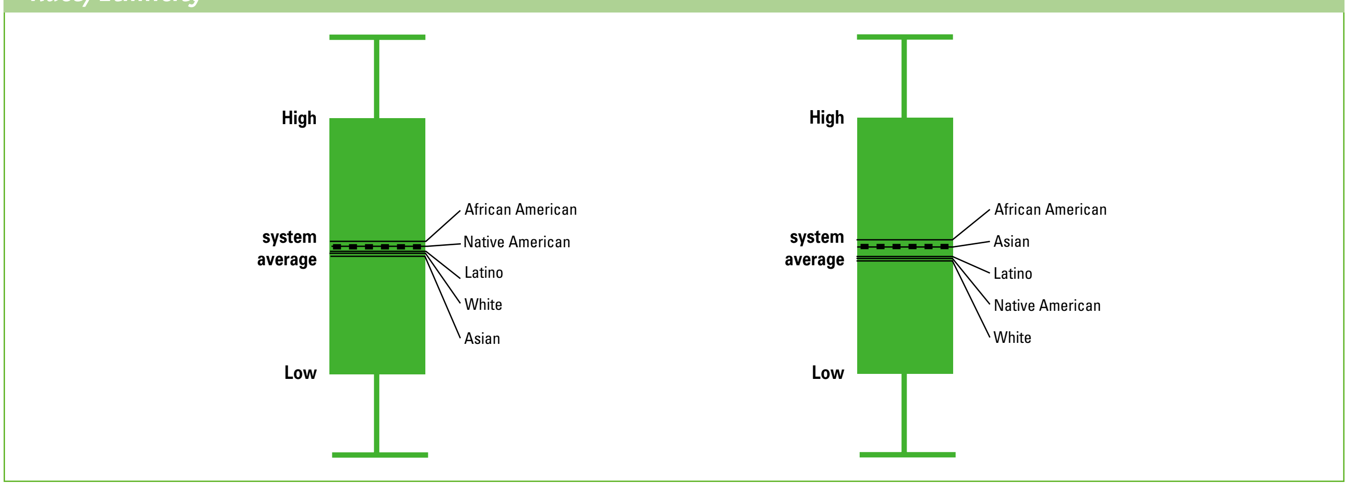
# ARE CERTAIN STUDENTS USING TECHNOLOGY MORE THAN OTHERS?

**Access to Technology at School** | **Use of Technology at School**

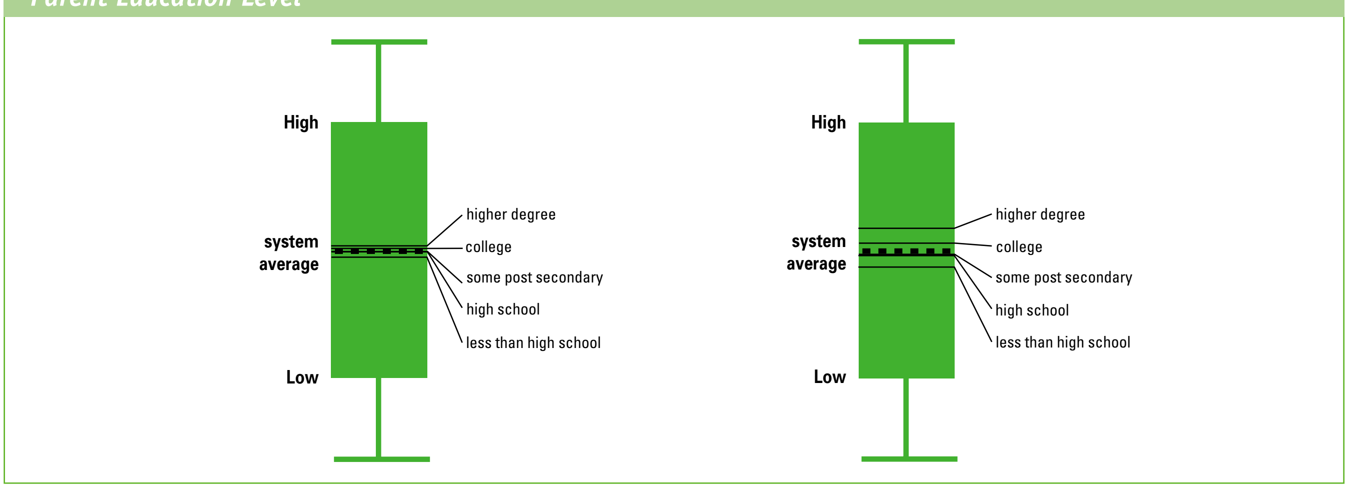
## *Family Income*




## *Race/Ethnicity*

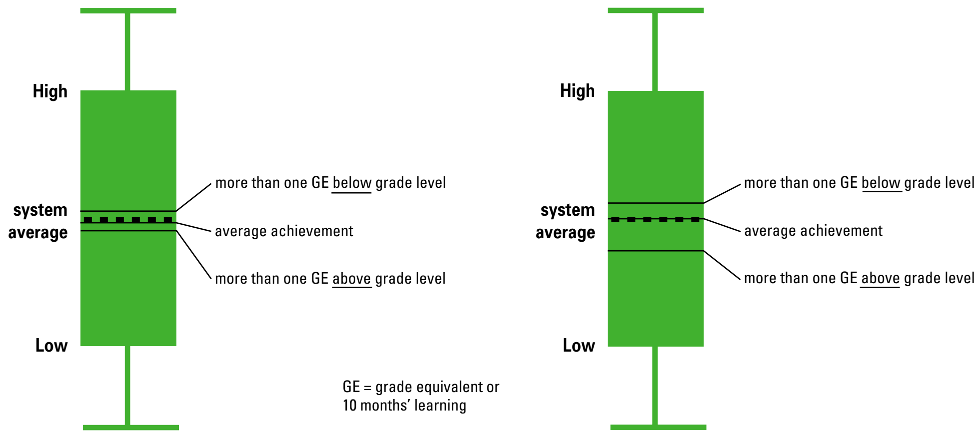



## *Parent Education Level*

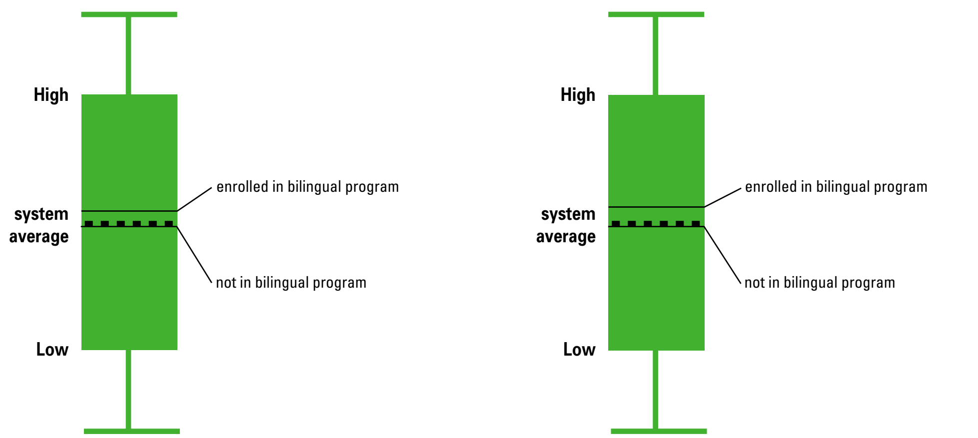


**Access to Technology at School** | **Use of Technology at School**

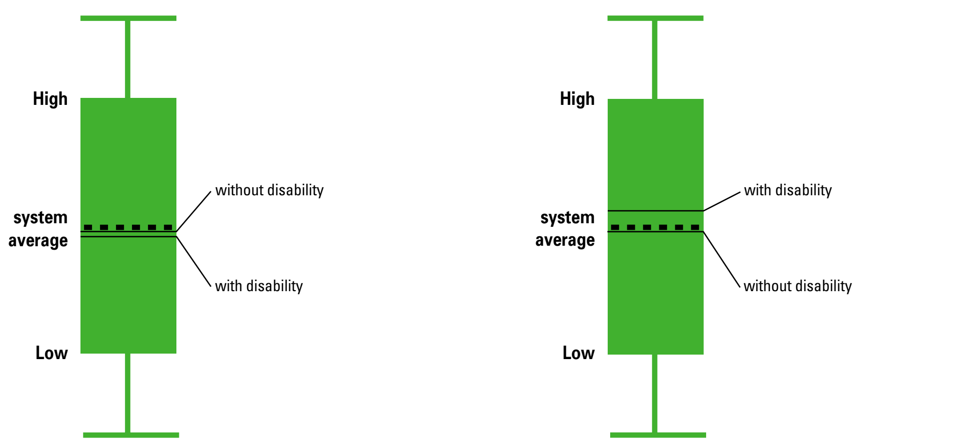
## *Individual Achievement Level*




## *Bilingual Education Status*

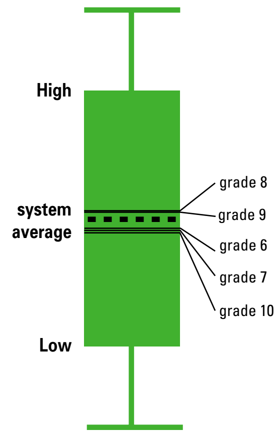


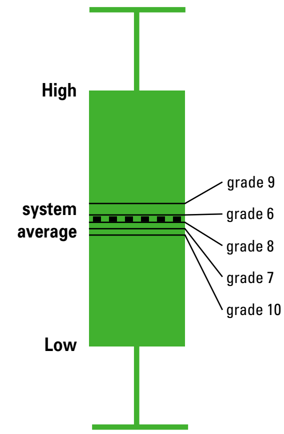

## *Special Education Status*



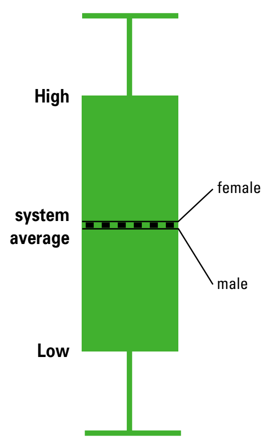
Access to Technology at School | Use of Technology at School

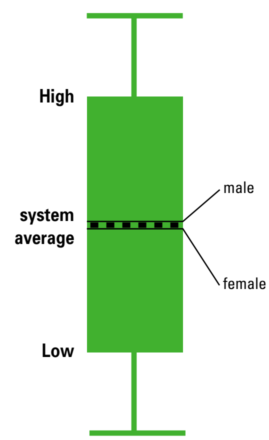
### *Grade Level*




### *Gender*

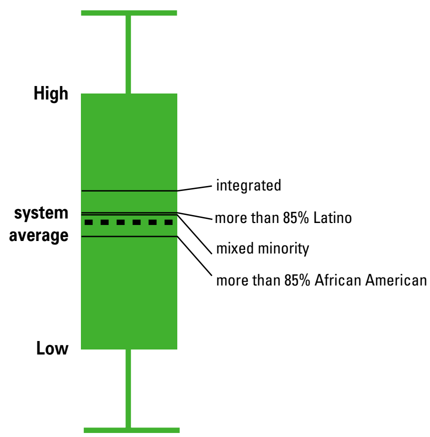


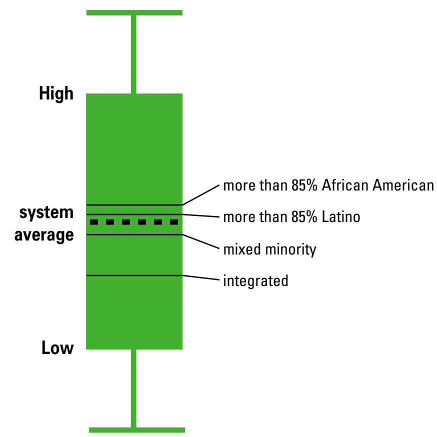



# DO STUDENTS AT CERTAIN TYPES OF SCHOOLS USE TECHNOLOGY MORE?

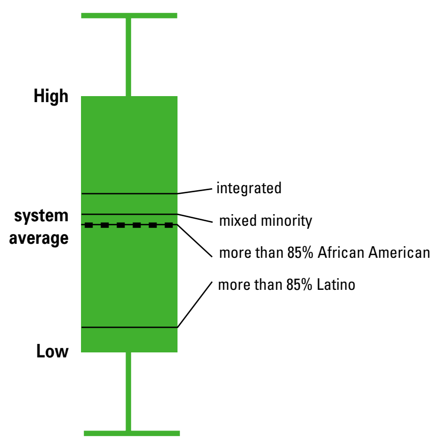
**Access to Technology at School** | **Use of Technology at School**

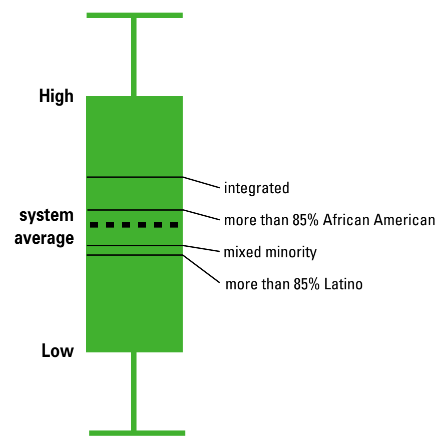
## *School Racial Composition: Elementary Schools*



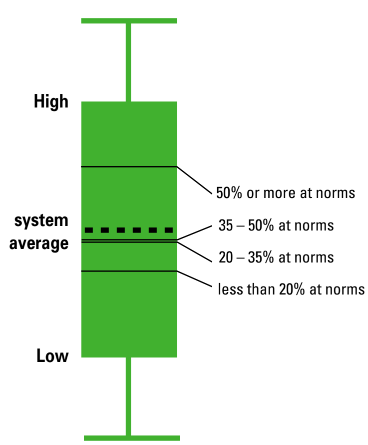



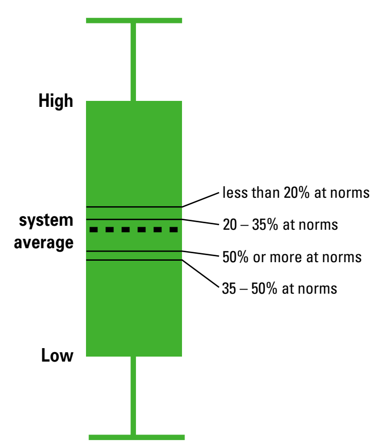

## *School Racial Composition: High Schools*



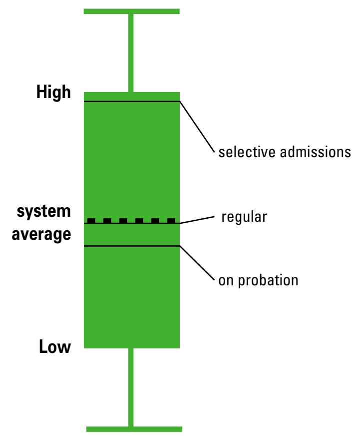

## *Student Achievement Level: Elementary Schools*

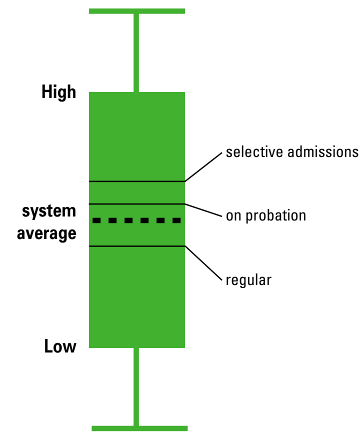


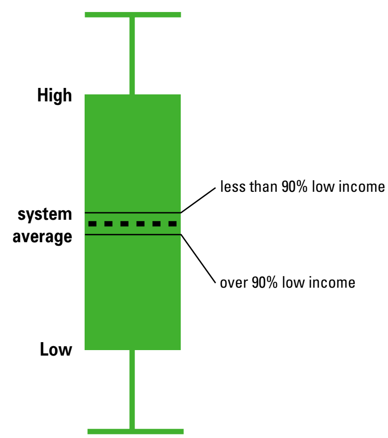
**Access to Technology at School** | **Use of Technology at School**

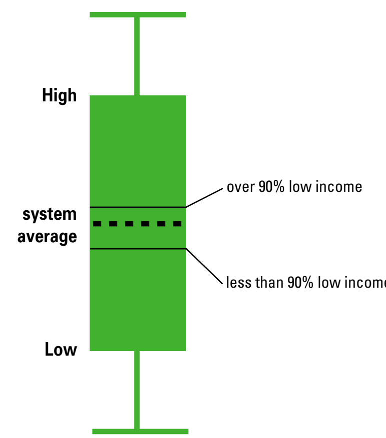
## *Student Achievement Level: High Schools*



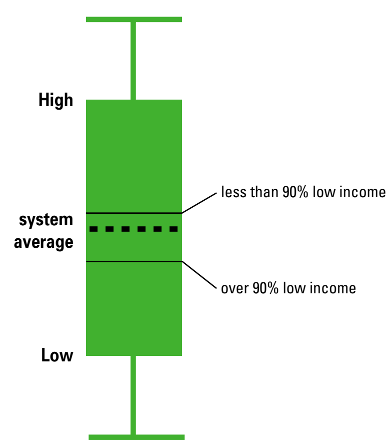



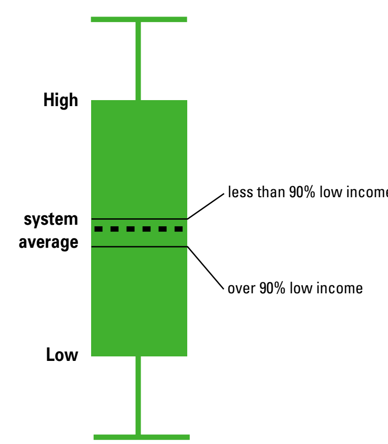

## *Percent Low Income: Elementary Schools*




## *Percent Low Income: High Schools*

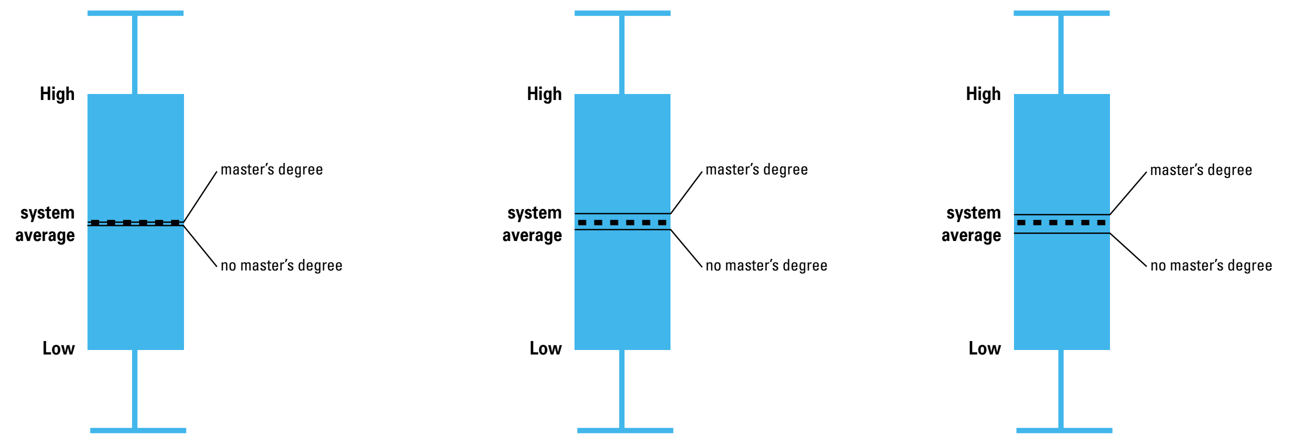


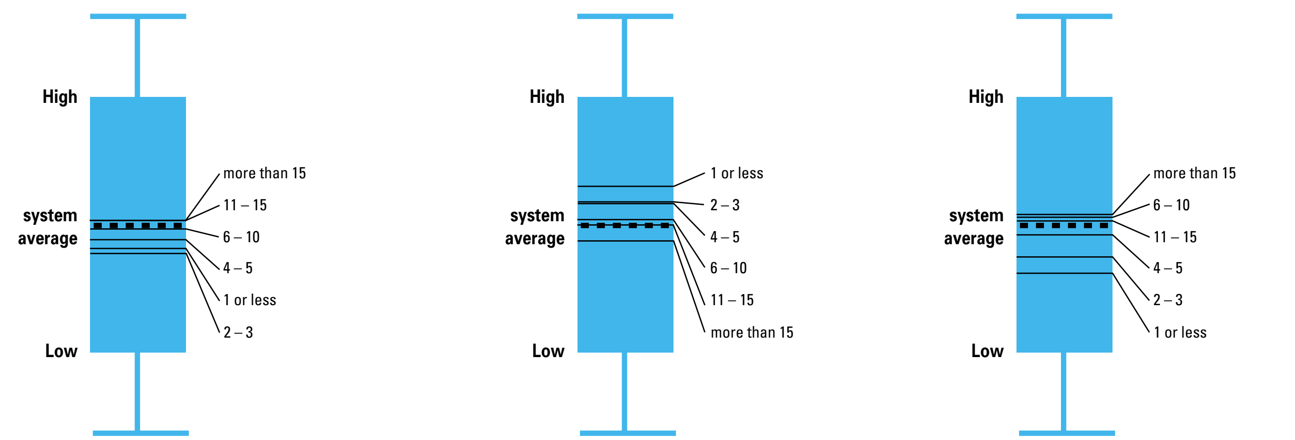
# ARE CERTAIN TEACHERS USING TECHNOLOGY MORE THAN OTHERS?

**Availability of Technology** | **Professional Use of Technology** | **Assignment of Technology**

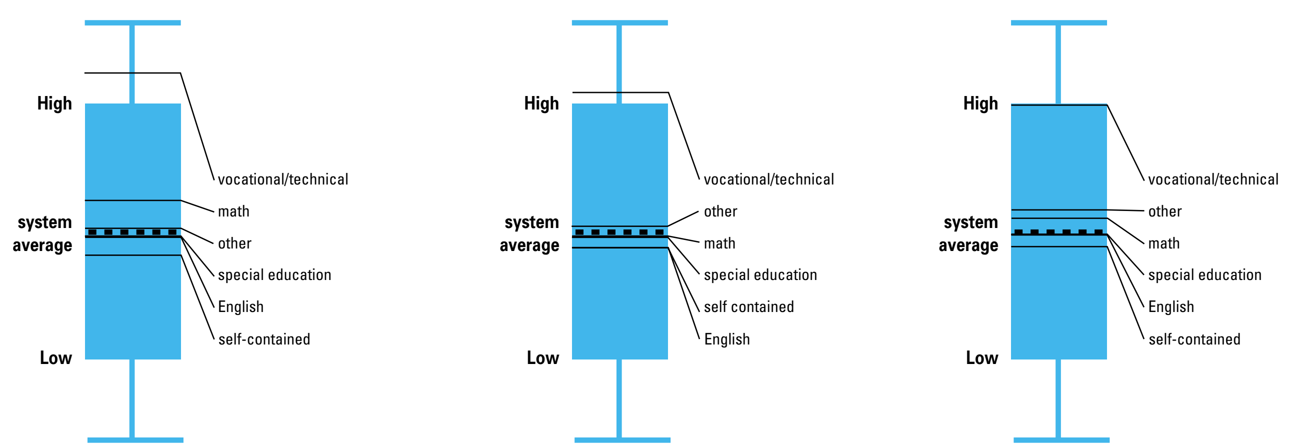
## *Level of Education*




## *Years' Experience*

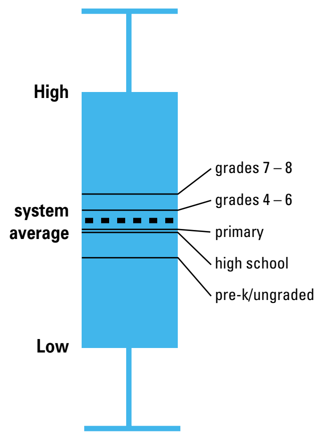


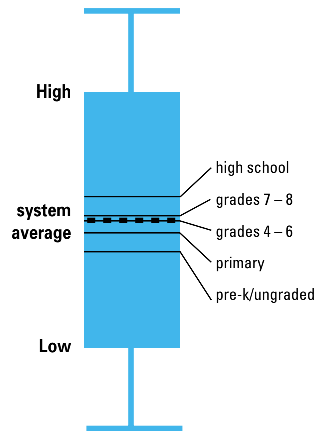

## *Subject Area*

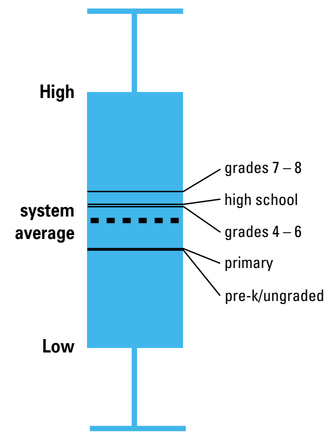


**Availability of Technology** | **Professional Use of Technology** | **Assignment of Technology**

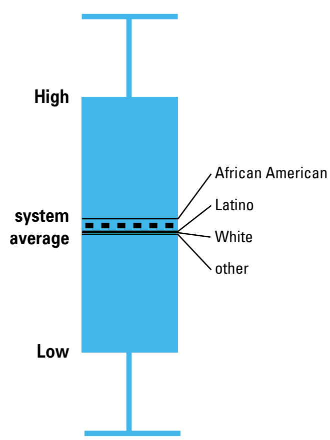
## *Grade Level*

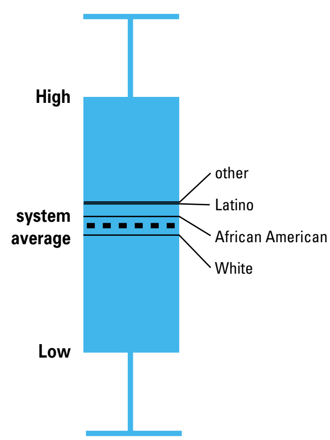


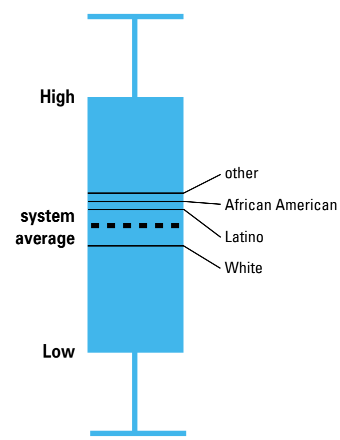



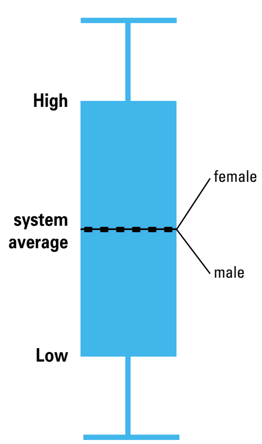

## *Race/Ethnicity*

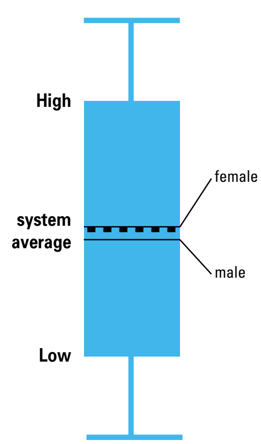


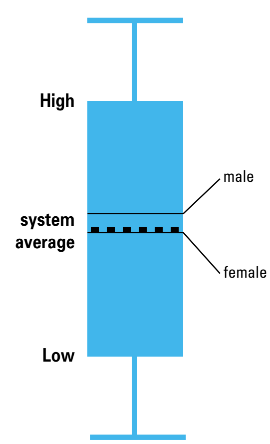




## *Gender*



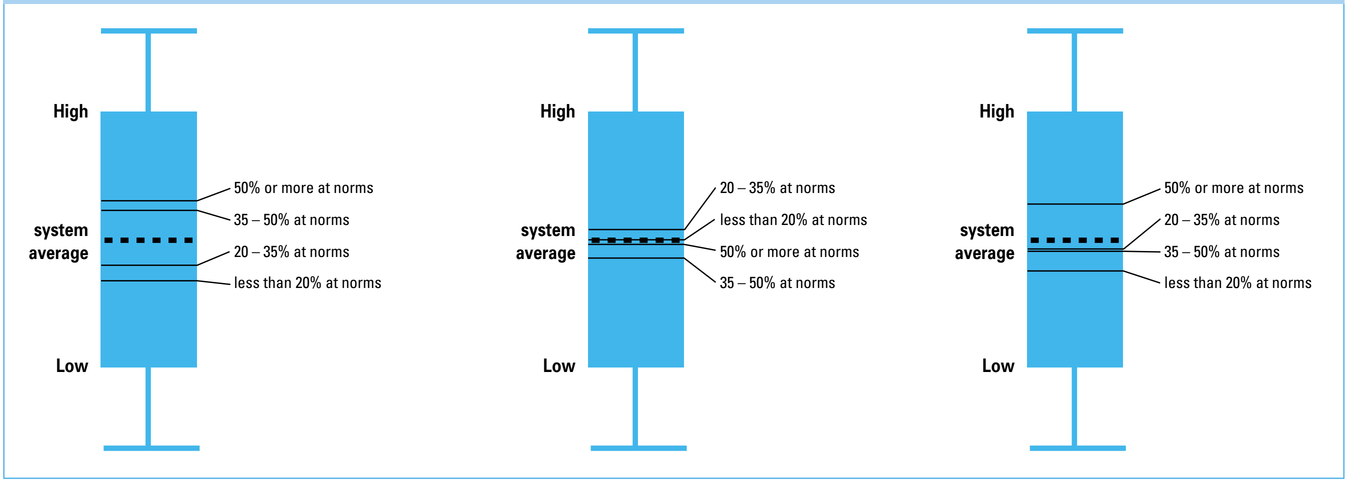



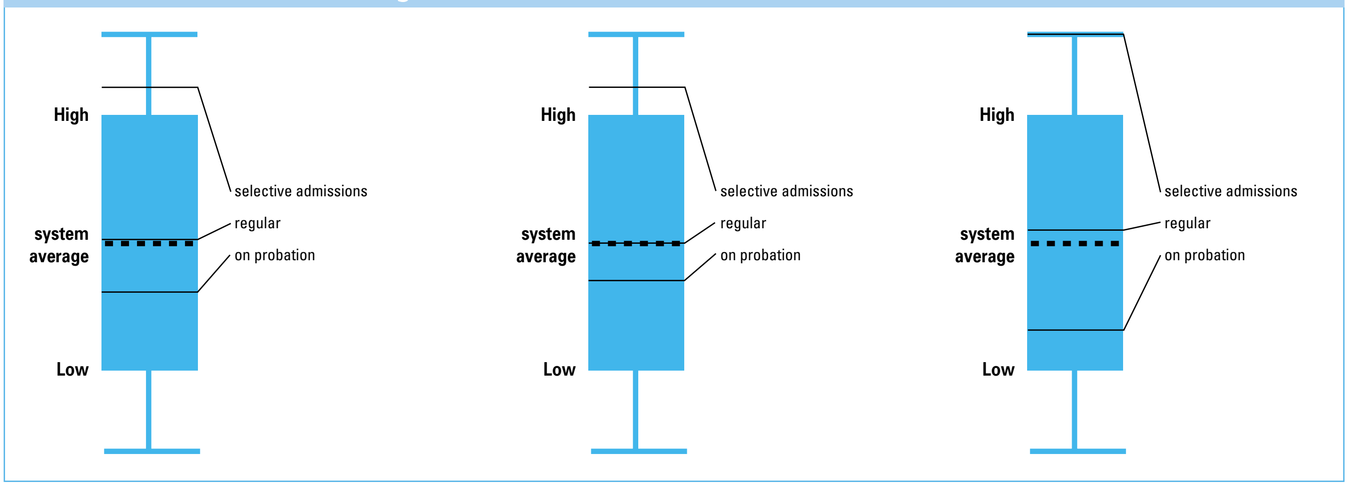
# DO TEACHERS AT CERTAIN TYPES OF SCHOOLS USE TECHNOLOGY MORE?

**Availability of Technology** | **Professional Use of Technology** | **Assignment of Technology**

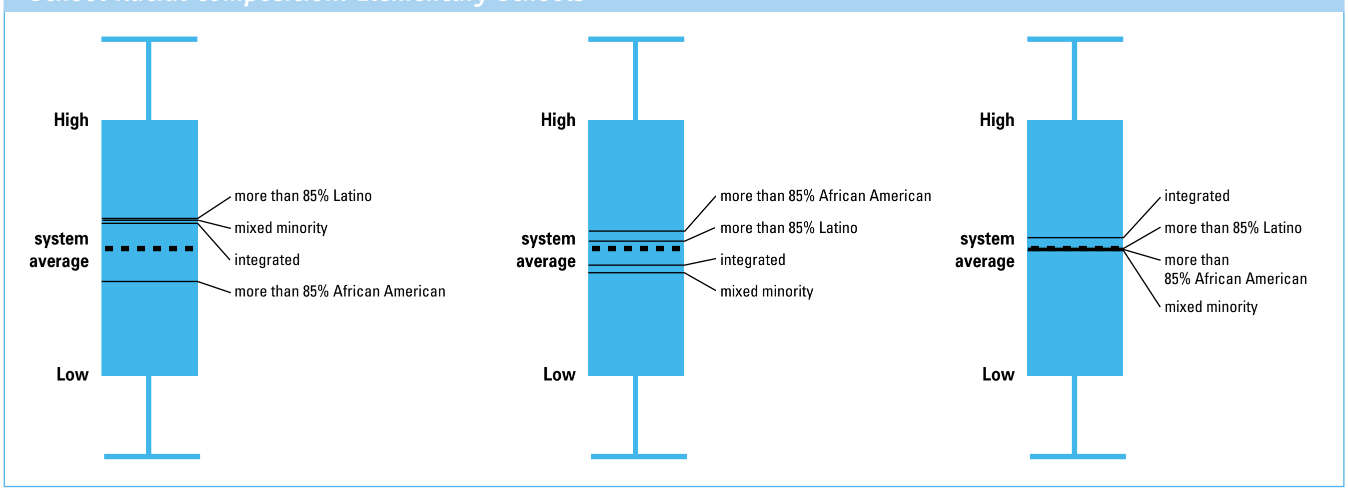
## *Student Achievement Level: Elementary Schools*




## *Student Achievement Level: High Schools*

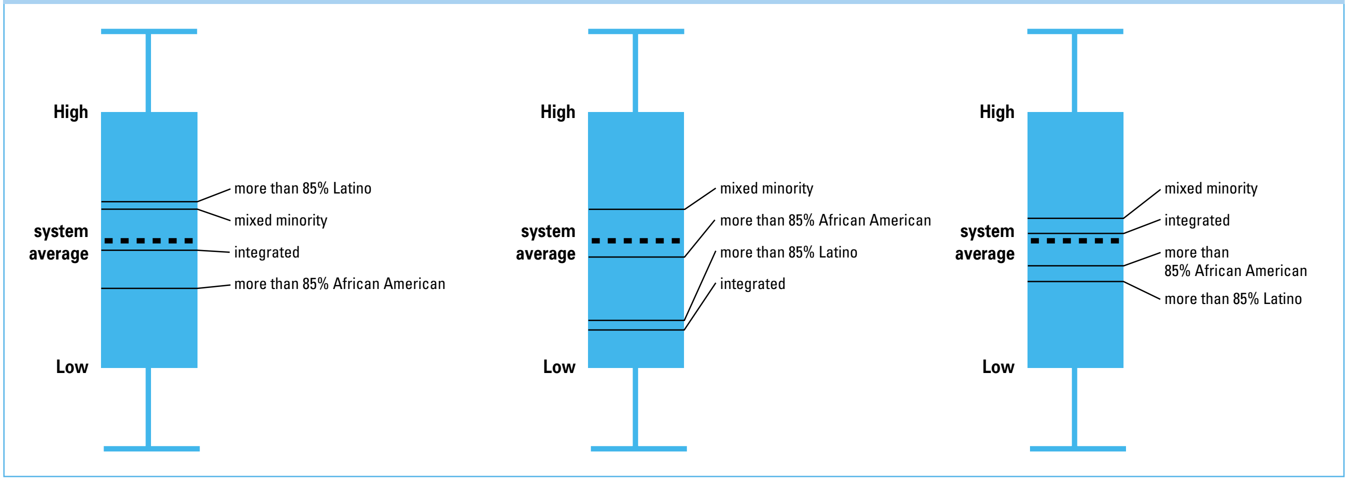



## *School Racial Composition: Elementary Schools*

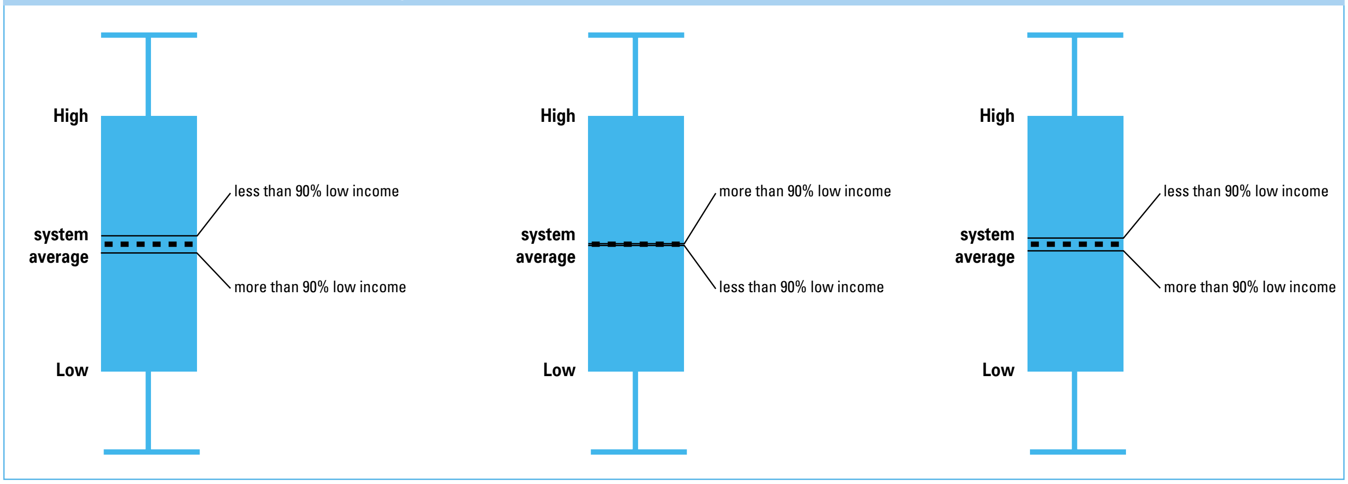


**Availability of Technology** | **Professional Use of Technology** | **Assignment of Technology**

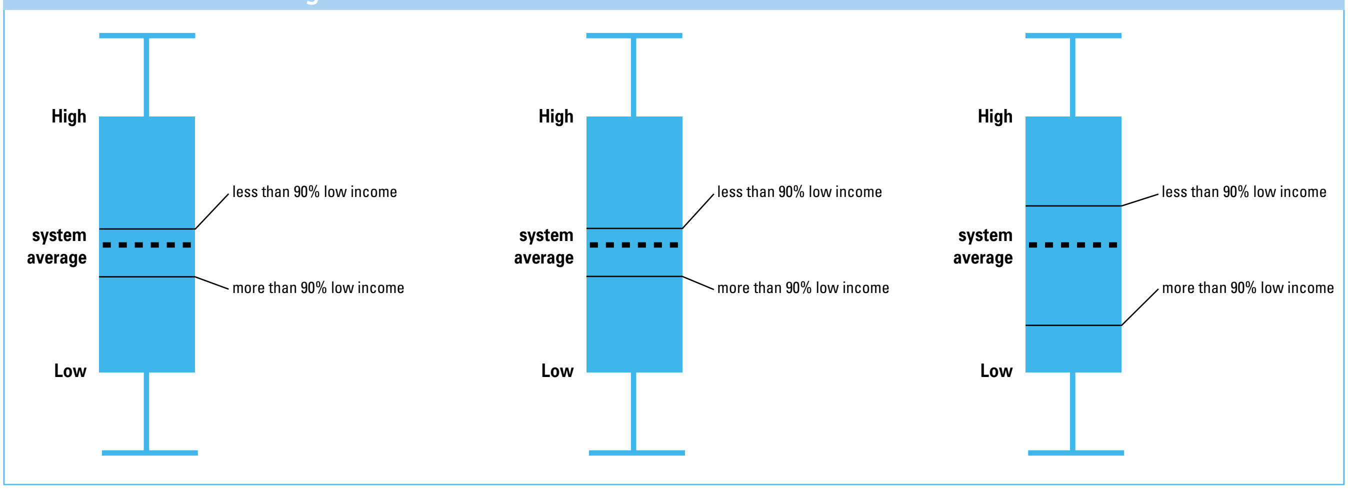
## *School Racial Composition: High Schools*




## *Percent Low Income: Elementary Schools*




## *Percent Low Income: High Schools*



# 4 What Encourages Technology Use in Schools?

In general, Chicago public schools have shown only modest progress in integrating educational technology in the classroom. Some schools, however, have exceptional technology programs. Their adoption of new technology practices both in and outside of the classroom is due to more than demographic characteristics and participation in systemwide programs. What about these schools makes them different than others? What are the supports that encourage technology use?

We organize our discussion of school structures that influence productive technology use around a framework of essential supports that builds on earlier Consortium studies of effective school development (see Figures 8 and 9).[30] We discuss each element of the framework separately, first by looking at factors that affect student use, and then at those that affect teacher use and assignment. Although we present some simple charts of bivariate relationships to demonstrate how variables of the framework are related, our conclusions are based on a series of statistical models presented in Appendix C. In addition to our statistical analyses of student and teacher survey data, we also conducted fieldwork in two model and one emerging school. The stories of Burley, Hayt, and Murray elementary schools provide a perspective on some of the obstacles and opportunities that many CPS schools face as they move foward.

### In This Chapter We Show:

- Factors that directly affect student technology use at school
- Factors that directly affect teachers' use and assignment of technology
- School structures that facilitate technology use

*Figure 8: Factors That Directly Affect Students' Use of Technology*

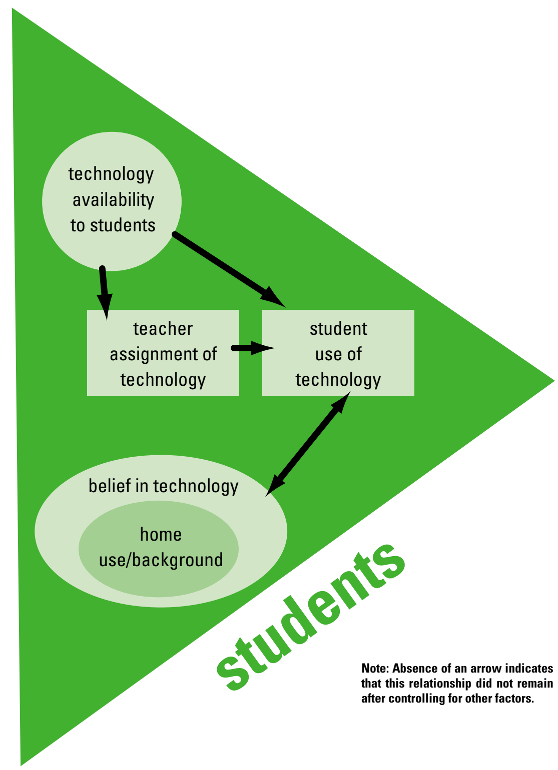
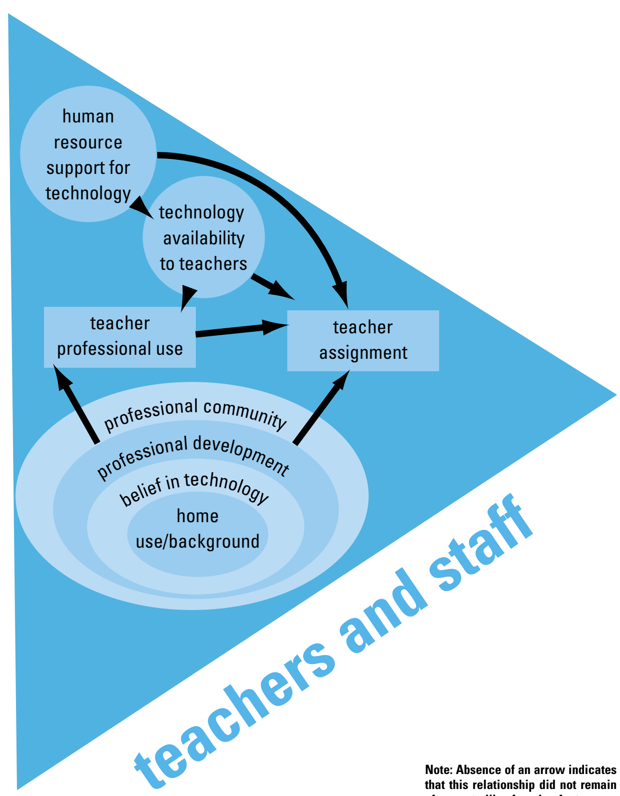



*Figure 9: Factors That Directly Affect Teachers' Use and Assignment of Technology*



## Strong Leadership and Extraordinary Effort: The Story of Two Schools

Hayt and Burley elementary schools and their principals are fairly similar. Their student enrollments are ethnically diverse and fairly high achieving. Both have efficient operations and administrative teams and involved Local School Councils (LSCs). Their principals share an excellent rapport with teachers, parents, LSCs, and the central office. They seek their teachers' input and encourage them to pursue innovative ideas. These principals are willing to take risks and work hard to make the contacts necessary to secure the resources their schools need. Their stories prove that any school's efforts to build a strong technology program require a continual focus on time and money.

Dr. Williamson, principal of Hayt Elementary, and Ms. Laho, principal of Burley, had both worked at their schools prior to becoming principals. When they assumed their new positions, each adopted technology as a key component of their new administrations. In both cases, they received support for their technology initiatives from teachers, parents, and their LSCs.

### Challenge #1: Hardware

Hayt and Burley happened on good fortune on this point. Dr. Williamson and Ms. Laho were both faced with the immediate need of securing appropriate hardware for their schools. Dr. Williamson approached TCI, a cable company new to the community and looking for a school partner, and convinced them that Hayt would be a good match. TCI provided the school with over a quarter of a million dollars worth of hardware, software, and training. At Burley, in the second year of Ms. Laho's principalship, the state threatened to recall a substantial amount of rollover funds. Ms. Laho chose to invest this money in technology and that year Burley spent tens of thousands of dollars outfitting each classroom with a computer.

### Challenge #2: Networking and the Internet

It took patience, determination, and discretionary funds to get Hayt and Burley elementary schools wired for the Internet. Although e-rate grants are a great opportunity for schools to get support to wire their buildings, schools must first demonstrate that they can plug computers in and use them. This means that many schools need a power upgrade before they can take advantage of the e-rate grant. Ms. Laho made the decision to commit a third of Burley's discretionary funds ($87,000) to pay for power upgrades rather than wait for the central office to provide it.

### Challenge #3: Training and Support

Once the resources were in place, both principals worked to help their teachers become more comfortable with their new instructional tools. They paid for technical support positions with their discretionary funds because central office did not provide funding to staff these positions. Moreover, candidates were difficult to find; they wanted someone with both technical and instructional expertise who would work for the available salary.

The need for training did not end once the position was filled, however. Burley had a lot of success with the CPS Technology Infusion Program, which provided professional development for teachers, but that program was dissolved. Hayt participated in many different partnerships with universities and other groups, including the Teachers Academy for Math and Science (TAMS); Northwestern University's Collaboratory; the Center for Learning Technologies in Urban Schools (LeTUS); LaSalle Bank; the Chicago Public Libraries; and DePaul, Governor State, Loyola, and Roosevelt universities. Dr. Williamson says she looks for programs that come to her school, provide coaching, and conduct follow-up sessions. Dr. Williamson says she thinks of her school as a laboratory. Many of the programs her school participated in were not ones she found herself, but that found her, "People hear what you're working at and they want to know about that. And people will help you, I think, if you're trying to help yourself."

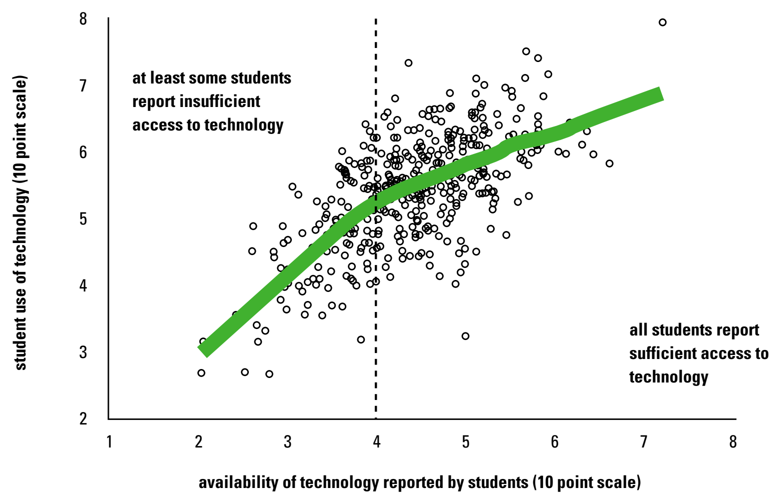
Although Dr. Williamson and Ms. Laho continually look for support and training opportunities for their teachers, they also expect their staff to take advantage of what has been made available. Ms. Laho takes a patient but firm approach, saying you have to "personalize your push" if you want teachers to "take a risk and devote their personal time to it." At Hayt, Dr. Williamson feels her teachers are ready for some tasks to be required, such as submitting lesson plans electronically. "After a while," she says, "you have to come to a conscious decision that you can't just say, 'Well, I hope you come along with this.'"

## STRUCTURES THAT ENCOURAGE STUDENT TECHNOLOGY USE

**Access to Technology.** The most obvious way that schools facilitate students' technology use is ensuring that there are a sufficient number of working computers for students to use. Quite simply, students are unlikely to use technology frequently if they have limited access to computers. In fact, availability explains almost half of the variation between schools in student use of computers at school.[31] Small improvements in computer availability are associated with substantial increases in student use, especially in schools with limited access. As shown in Figure 10, this continues until most of the students report sufficient access, at which time it weakens but persists (the vertical line represents the point at which all students report sufficient access).

Even in our technology-rich fieldwork schools, principals and teachers faced the problem of providing their students with adequate access. Because greater use leads to greater demand for resources, the problem of availability persisted. For example, despite having one to three computers in each classroom and a computer lab, one principal continued to feel her school didn't have enough computers.

*Figure 10: Relationship Between Technology Availability and Students Use is Strongest in Schools with Insuffcent Access*



> There aren't enough computers in the classroom and there aren't enough computers in the lab to send a whole group of kids in there. So logistics is one of those obstacles that we are constantly trying to overcome. This year we literally, for intermediate and upper grade children, split the class in half; half would go to the library and half would go to the computer lab and the teacher would put together a unit of some kind where French research was appropriate in the library or draft writing or whatever and web research or web design was what they could do in the lab, because we can only fit half of them.

Even when teachers are completely satisfied with current availability, there is always the concern about replacement of outdated equipment. As one teacher said, "I'm very, very, very lucky to be able to access these laptops, but they are getting outdated...So I foresee when these start to get shot, I might have one more year out of them, then what do I do?"

**Integration into Assignments.** Once schools have sufficient computers, the most direct way to encourage students' technology use is by incorporating it into assignments. In schools where many teachers integrate technology, students are much more likely to report substantial computer use at schools. The extent to which teachers are able to do this also depends upon the degree to which technology is available.

## Students' Backgrounds and Beliefs Influence Use

Students come to school with various levels of experience with computers at home. They also have their own beliefs about the benefits of using new technologies. Although both of these factors, home use and beliefs, might be expected to influence the level of student use at school, we found that beliefs are a more important determinant. Students who believe in the utility of technology are far more likely to use computers at school whether or not they use it substantially at home. Students' computer use at home is only weakly associated with school use. Students who do not have access to computers at home are only slightly less likely to use technology intensively at school.[32]

The relationship between students' beliefs about technology and the extent of their use is probably bi-directional. Through providing adequate computer access and engaging assignments, schools are able to build enthusiasm for technology among students who would otherwise have had little exposure. On the other hand, students who are already enthusiastic will seek it out more when it is readily available. This is good news for schools—although they may have little influence over students' use of technology at home, they can have a substantial impact on school use by exposing students to technology and helping them recognize its utility.

# STRUCTURES THAT ENCOURAGE TEACHER TECHNOLOGY USE

## Teachers' Individual Capacities

**Personal Use.** Not surprisingly, teachers who are comfortable with technology and use it often are more likely to expect their students to use it as well. The strongest predictor of teacher assignment of technology is the extent to which they use technology for their own professional work.[33] Likewise, teachers that use technology extensively at home are more likely to use it for their professional work at school.[34]

Many teachers feel self-conscious about their lack of computer skills compared to other professionals, and sometimes even to their students. One teacher joked, "My parents...know so much more about technology than I do, my sister [too], and they are way ahead of me....I am like the family dope when it comes to technology....But here, yes, I'm the 'Deputy Technology Coordinator.'" Unfamiliarity with technology leads to anxiety about how it will work and how to deal with problems when they arise. As one principal said, "If [the computer] doesn't work exactly the way it's supposed to work, [the teachers] get very frustrated and are afraid to fool around for fear they are literally going to break the computer." Without the freedom to get comfortable with technology, teachers sometimes find starting to use it difficult. One principal found a program that offered low cost laptops to teachers to be an excellent way for teachers to become more comfortable, "Time is in my mind the biggest obstacle....So, being able to provide teachers with a computer at home gave them a little flexibility with regard to time and playing around with it, which is what one has to do."

**Professional Development.** Increasing teachers' comfort level with computing technology is only the first step in building a technology-rich curriculum. Most teachers need additional support to incorporate these new tools into their professional and classroom work. One principal realized that, despite having a number of fairly computer-literate teachers, she had to do more:

> They're on the Internet at home, they use it for research for their work, they're using it in all the kinds of ways that people do on a personal level...but how does it translate into the classroom? And so that was an eye opener for us. Because I think we all felt and I felt that if you personally knew how to use this well, the translation into using this in the classroom would not be that hard. But actually it's such a different experience. What you need to know and what you need to think about is so different that in that sense they were starting over.

In our survey of teachers, we asked not only if teachers had taken professional development, but also if they felt it was meaningful. We found that teachers who reported receiving useful professional development were more likely than other teachers to integrate it into their classroom assignments and to use it for their own professional work.[35] In fact, differences in professional development experiences explain a substantial proportion of the school variation in teachers' assignment and use of technology. This suggests that groups of teachers at some schools received professional development that significantly increased the degree to which they use technology for their own work and integrate it into their classroom teaching.

In our fieldwork schools, teachers and principals seemed to find professional development most helpful when it provided: (1) training in the school for a group of teachers who would be working together afterwards; (2) modeling by other teachers in the classroom with students; and (3) time and guidance to develop lessons or other materials that could be directly translated to teachers' own classrooms. One principal explained:

> [We] found that just sending someone out to a workshop, oftentimes it's in such isolation. You don't get the whole impact of what they got, for the whole group....So we actually want you to come into the classroom, team with that teacher, model a lesson, show that person how they can do that better. So we tend to look for those kinds of staff development opportunities.

Another teacher described what she found most useful about her professional development program, "Well, it allowed you to create something that was useful. Because a lot of times you get these nice resources when you go to an in-service or whatever and it sounds good, but in terms of having time to take it from that theory to your specific needs and then using it, it's usually lost."

**Beliefs about Technology.** Teachers' attitudes also play a significant role in the degree of their technology use. Those who believe in its utility are most likely to use it for their own work and to assign it to students. Attitudes about the value of technology for students are shown to be important, even after controlling for the level of teachers' personal use. This suggests that even if teachers are not especially comfortable using technology in their own professional work, they may ask their students to use it if they think it is a beneficial learning tool.[36]

Teachers' ability to use technology, their belief in its importance, and the quality of their professional development represent their individual capacity to promote technology-rich learning. In our quantitative analyses, individual capacity accounts for 40 to 70 percent of the differences between schools in teachers' technology use, depending on the school (elementary or high school) and type of use (teachers' own professional use or assignment to students). Therefore, teachers' personal capacities and their development of them are strong determinants of how extensively technology is used in a school.[37] It is important to stress, however, that individual capacity is shaped by the larger school environment.

## School-Level Structures that Promote Teachers' Technology Use

**Supportive Professional Community.** A key structural element that shapes teachers' capacity to integrate technology into their teaching is the degree to which a professional community promotes technology use. Professional development is more productive when a group of teachers is able to share what they've learned and master and develop it further together. Working as a team to locate and evaluate resources can make the overwhelming abundance of books, websites, and training opportunities more manageable for teachers. Teachers who learn new approaches also can serve as models for others. In our fieldwork schools, new technology practices often started with a few teachers and spread as the teachers shared what they learned with others. As one technology coordinator said, "Let's say there are three teachers in a unit, if one starts doing something and then shares it, then the other teacher says, 'Well maybe I could try that. Can you help me do that?'" A principal shared a similar experience, "Once that first group was trained and had worked for that year then I looked for some teachers for the second year....And then of course we made sure that the teachers who had already [gone through the training] assured the new ones that they would help them....and I think that was a big piece that was very important."

Our survey data confirms the importance of professional community. In schools with a strong professional community around technology, teachers report participating in more professional development and are more likely to report that those experiences were positive.[38] Of course, this relationship is reciprocal; as teachers work together on professional development they develop a stronger professional community.

**Adequate Access to Technology.** Even the most computer savvy teacher cannot be expected to use technology if he does not have reliable access to the equipment he needs. For beginning teachers, limited availability may be so frustrating that they retreat from any effort to integrate it into their teaching. The more technology is available, the more likely teachers are to use it for their own professional work, and the more likely they are to assign it to their students. Furthermore, teachers' ability to integrate technology into their teaching is shaped by the degree to which computers are available for students, regardless of what is available for their own work.[39] In schools where there is greater access, teachers assign and use technology more, regardless of their individual capacity.[40]

**Human Resource Support for Technology.** In both survey and case study data, we find that the extent to which technology is available to teachers and students is strongly associated with the amount of human resource support for technology in the school. Survey data show very strong positive relationships between human resource support and students' and teachers' reports of availability.[41] One principal explained that her school learned the hard way that a technology coordinator was crucial:

> We did go through a number of years where we...thought well, there's enough of us who know all these things about computers that we can do this ourselves. Including keeping them all running. And what we discovered the hard way was that we could not. So it's unfortunate that I think that there isn't a recognition at large yet that really a technology coordinator in every school is a must. It's not a luxury. It's not a luxury. And we really did do I think everything possible to avoid spending the money in that way.

Another principal related a similar feeling,

> Stuff happens with the hardware and not that somebody did something wrong; it just happens. And to have somebody in the building who is able to go to the room and fix it or talk to the teacher....If there isn't that kind of person in the school, I can see why if something breaks or something doesn't work right, it just sits there because you don't have the $400 an hour or whatever they charge to come out and fix the machines.

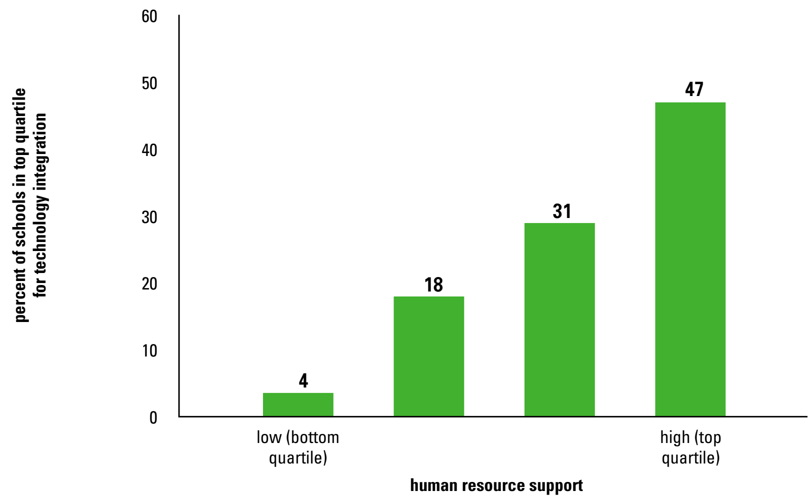
Beyond simply keeping the equipment running, which in itself is a demanding task, the teachers and principals we spoke to valued their technology coordinators for many things: teaching basic computer skills; modeling lessons; assisting teachers by providing techniques, programs, tips, resources, and even specific ideas. Not surprisingly, our survey data also show that human resource support increases the likelihood that teachers will incorporate technology into their teaching (see Figure 11).[42] One case study principal described what happened when they hired their technology coordinator:

> It makes a statement that we really are going to put our money where our mouth is and we value this....Because our discretionary money is small, we talk long and hard before we spend it. Then also I think when you have someone come in who knows what they need to know about instruction...that's exciting to the teachers cause it's a colleague that they can work with...who also knows this other subject piece, which is what technology can do and how to use it, it's pretty exciting.

Finding a technology coordinator who fulfills both these needs is another challenge. Several of the case study principals discussed the difficulty of staffing these positions:

*Figure 11:*

*Teachers Assign Technology More Often When Human Resource Support is High*

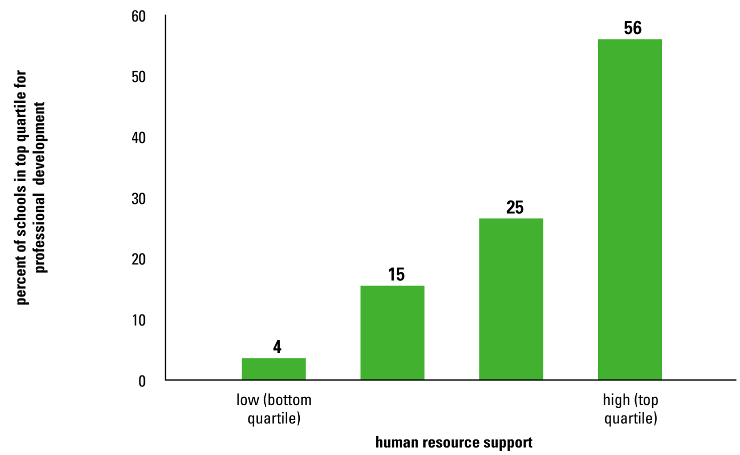



> I have a staff here who really understands how to teach and they understand what current research says. I cannot have somebody come in who cannot support them instructionally, otherwise what's the point?...It took me two full years of interviewing to find somebody who both knew the technical side...and at the same time knew what good instructional practices look like and be able to support that.

Such assistance is not limited to a technology coordinator per se. In our fieldwork schools we observed not only technology coordinators helping teachers, but also college and graduate student volunteers, student teachers, and outside groups working in schools. A dramatic illustration of the benefits of extra technology support took place in a classroom of third graders learning to graph data for the first time. There were four adults (the technology coordinator, her assistant, the classroom teacher, and her student teacher), all busy throughout the class period responding to raised hands. This lesson was greatly facilitated by the number of teachers and assistants. Imagine the enormous challenge faced by an individual teacher, new to this skill herself and alone in a classroom, dealing with a constant stream of both substantive and technical questions, as well as equipment glitches. To be able to integrate technology into the complex web of classroom life, and to integrate it well, schools need more than just equipment or training. Technology coordinators and, in some cases, external partners help teachers direct their own professional development (see Figure 12).

*Figure 12:*

*Teachers at Schools with Substantial Human Resource Support Are More Likely to Have Positive Professional Development Experiences*




## THE IMPORTANCE OF SCHOOL LEADERSHIP

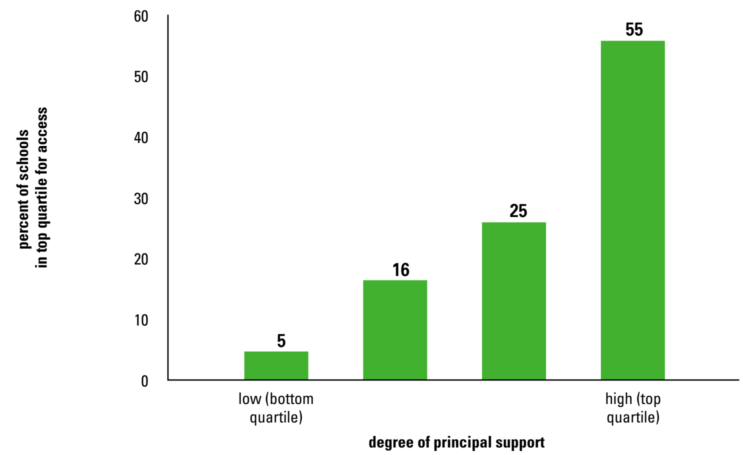
Moving a school toward effective technology use is a multi-step process—first there's the need for access, and then there's training. The key to creating any technology-rich environment, especially in a decentralized district like Chicago, is a school's leadership. Introducing and integrating technology demands an enormous amount of resources; leadership must be committed to making technology a priority. As one technology coordinator explained, "It costs an awful lot of money to do all of this stuff, and it's a terrible money-hungry beast because there is always new stuff coming out." Most school budgets are not sufficient to provide equipment, power upgrades, and wiring. Someone must write grants, seek and accept donations, and implement pilot programs. In the absence of district funding, CPS principals have to find alternative resources to provide adequate technology resources and support. Principals in our technology-rich fieldwork schools did an enormous amount of networking. They and their technology coordinators were always seeking new resources. A teacher gave the following example:

> You can't do this unless...the administration makes a commitment to say—okay, we're going to do this and we're going to find the money to do this. We had a guy here, he was the math/science coordinator, but basically all he did was write grants and for, I think, two or three years in a row, he brought $400,000 a year into the building....You just have to have somebody...[who] can give a couple of hours every day to getting the grants written....But, if the administration doesn't believe in it, then it's not going to happen.

Not surprisingly, our survey data show that technology availability in school is strongly associated with principals' support for technology (see Figure 13).

*Figure 13:*

*Teachers Report More Access to Technology in Schools with Strong Principal Support*




Principals are also the driving force behind developing staff capacity, which they do by hiring teachers who are excited by the school's technology plan, and by hiring human resource support. Principals influence the kind of professional development that teachers receive and can encourage teachers to incorporate new skills into their work. They promote new practices by giving teachers time to learn new skills, prepare new lessons, and work with their colleagues. Principals also define expectations for technology use in the school.[43] One principal argued that this last function was very important, "You also have to be willing to not only talk to your staff as a group, but talk to your teachers one at a time and say, 'I really think the time is right for you to do this. This is in place, this opportunity is here, and really, you know, I'm hoping you'll reach out and participate,' and I think you have to take the time to do that."

Survey data confirm the important roles principals play in developing their staff's technology capacity. This support is not only strongly related to the degree that human resource support is available in the school, but also to the quality of teachers' professional development and the strength of the school's professional community (see Figures 14 and 15). Finally, school leaders are often the authors of their school's vision of how technology should be used and are responsible for its realization. Through their support and leadership, they foster environments where teachers are comfortable with possible failure and where teachers receive the training they need. Such direction is not limited to the principal alone. In one case, the LSC initiated the school's commitment to technology by finding a way to fund a technology coordinator.

*Figure 14:*

*Principal Support Is Strongly Related to Greater Human Resource Support*

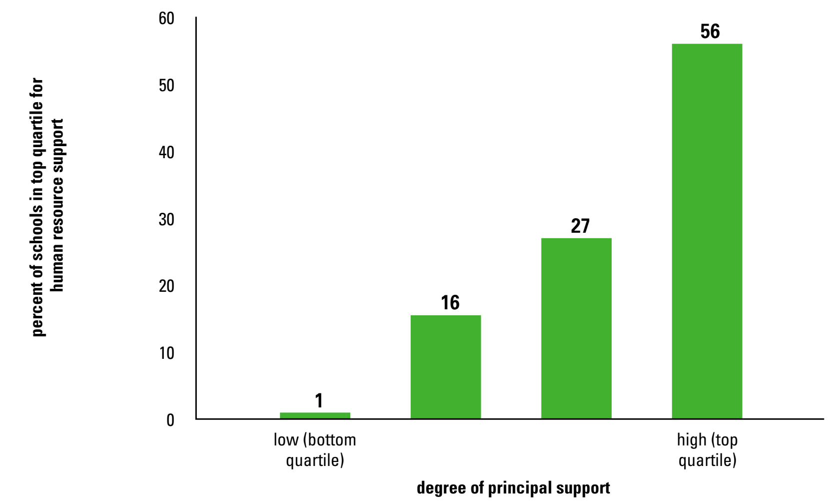
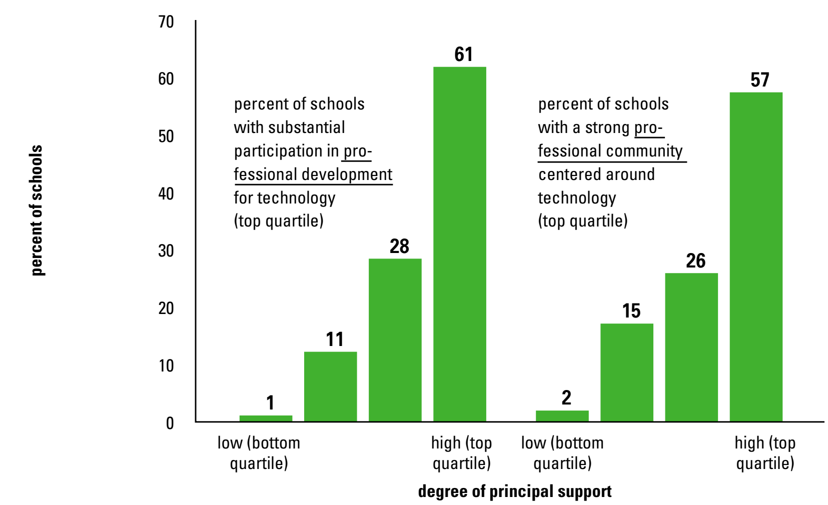



*Figure 15:*

*Principal Support Promotes Professional Development and a Professional Community Centered Around Technology*



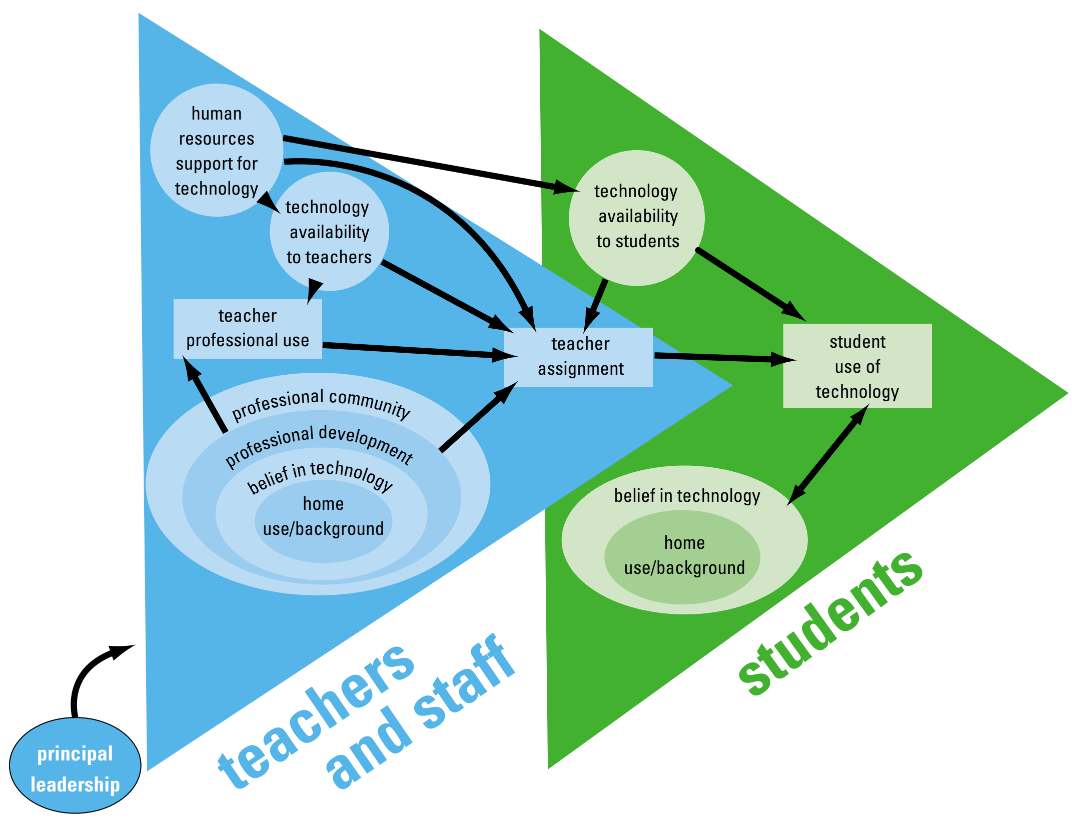

One challenge principals must overcome is ensuring that students from all classrooms receive similar opportunities. Survey data show many more differences in technology use among teachers and students in the same school than differences across schools.[44] A fieldwork principal recognized this as a problem, "I think another challenge is to try to find some equity across the building...so that every child, regardless of whose classroom they're in, has this advantage of having a really truly integrated curriculum with technology as one of its pieces."

## SUMMARY

Creating technology-rich learning environments takes more than a one-time infusion of computers, or even a few professional development seminars on basic technology use. As Figure 16 shows, many distinct components are necessary to make technology a regular part of students' academic lives. First, school leadership must be committed to developing students' and teachers' technology capacities, and have a vision to meet those goals. Crucial to leaders' commitment is providing financial support. Substantial financial resources must be found and made available to make a significant initial investment and provide ongoing support, upgrades, and expansion. Computers, infrastructure, and human resource support are all necessary. Some districts may be committed to adopting technology and so work with schools to secure appropriate funding. In Chicago, however, the handful of schools that have highly integrated technology programs have done so only through very active and creative efforts.

It is important to stress that simply providing adequate resources is not enough to ensure that they are used well. Teachers' capacity to use technology must be developed—they must feel comfortable with computers, how they work, and what the possibilities for their use are. Teachers need continual support to learn how to incorporate technology into their teaching. It is easiest to achieve this when there is a professional community around technology; teachers need a

*Figure 16: Essential Supports for Educational Technology*



community in which they can help each other, model lessons, and receive support from the principal and technology specialists. We found that teachers' individual capacity with technology, which includes their personal use of technology, beliefs about, and the quality of their professional development, was a strong determinant of their success in bringing technology into the classroom. Moreover, this was greatly shaped by the human resource support they received and the extent to which technology was available for their use.

Finally, students need to see technology in action and believe in its importance for their academic success and future. Students who believe in technology's utility are more likely to use it at school, regardless of their home access or experience with it. Schools can work to compensate inequities in computer use at home by providing access at school and encouraging technology use by actively promoting its integration in classroom lessons and assignments.

Those schools that can least afford to allocate monies for investment in technology may be those schools that serve students who are least likely to have computers at home. It may be difficult for a school on probation to rationalize spending for a new technology initiative at the expense of other instructional programs. As long as technology funding is left to the discretion of schools, CPS can expect wide variation in computer use among its schools.

## New Technology Initiatives of the Chicago Board of Education

Since spring 2001, the Chicago Board of Education established a new entity called the eBrigade to address technology issues in CPS schools and provide the district with a strategic plan. Members of the eBrigade include community leaders, local and national educators, administrators, and technology professionals. The eBrigade's first task was to assess the role education technology plays in CPS schools and in other districts. They spent 18 months interviewing teachers and administrators, conducting best practice studies, organizing focus groups and community discussions, and visiting schools. A list of findings and plans can be found on the eBrigade's website (http://ebrigade.cps.k12.il.us).

The eBrigade has begun to implement some changes to CPS's technology structure, which includes massive reorganization of departments and staff. The Department of Instructional Technologies (DoIT) was created within the Office of Professional Development to provide leadership, support, and development of appropriate technology training for teachers and staff. DoIT has also developed assessment tools and strategies to evaluate current professional development offerings and the current levels of computer and Internet proficiency of CPS teachers. The department has established the Curriculum, Instruction and Technology Integration (CITI) program to integrate technology into all curriculum departments.

The eBrigade has listed the following accomplishments on its website:

- Wiring all CPS high school classrooms, computer labs, and libraries
- Completing minimum wiring configuration for 50 additional elementary schools,
- Providing all principals with email accounts
- Distributing 6,000 laptops and web-based email accounts to high school principals, teachers, librarians, and technology coordinators, and distributing refurbished computers to schools.

Before the end of 2002, the eBrigade also plans to implement several more initiatives, including:

- Creating online learning communities for high school teachers and librarians
- Providing email to teachers
- Providing one computer to each high school teacher and graphing calculators for all high school students
- Supplying 140 elementary schools with minimum configuration
- Developing a strategy to provide schools with maintenance and support.

# 5 Where Does Chicago Stand and Where Does It Need to Go?

Students and teachers in Chicago's public schools believe that technology is important for both succeeding academically and preparing for the labor market. And yet, use across the system is rudimentary; most students do only occasional word processing and Internet searches and most teachers only use technology to create worksheets and tests. Some CPS schools, selective admissions high schools in particular, have been very successful in creating technology-rich learning environments. Many of these schools were built or remodeled in recent years, however, and technology was a central focus of both their physical and curricular designs. A few other schools have successfully procured sufficient technology resources and integrated it into their teaching. This was accomplished, however, only by the very active efforts of school leaders committed to this goal. In most schools, a few students and teachers are comfortable with technology and use it intensively while the rest use it rarely, or only for simple tasks. There are even some schools that have few to no working computers and no Internet capacity.

Our portrait of technology use in CPS schools is not altogether surprising. Educational technology is an enormous and costly innovation, particularly for a large urban school district like Chicago. Moreover, its adoption is complicated by the decentralized nature of Chicago's system. In general, technology has not been a primary focus of the administration (the Board has taken steps to change this with its creation of the eBrigade, see page 53). This has left individual schools in the position of finding their own resources. Besides the obvious obstacles of securing expensive hardware, schools have had to initiate many of their own renovations to their physical plants such as power upgrades and Internet wiring. Many of the supports crucial to developing a technology-focused school, such as qualified technology coordinators and effective professional development, are difficult to both find and afford.

Although it is easy to identify the reasons why Chicago lags behind other cities, the business world's technological demands are changing and CPS students must be prepared to compete with students from smaller and more advantaged districts. Equity analyses indicate that CPS schools are largely not replicating the digital divide that is currently present in homes both locally and across the nation. At the end of the day, however, low levels of equitably distributed technology access and use at school will not compensate for students' infrequent home use. In *The Connected School: Technology and Learning in High School* (2001), the authors observe, "Given differences in home access and support, students in urban schools need not just equal but better access to technology and high-quality learning activities involving technology if they are to get to the same place as their peers in well-to-do suburban schools."[45]

***Although it is easy to identify the reasons why Chicago lags behind other cities, the business world's technological demands are changing and CPS students must be prepared to compete with students from smaller and more advantaged districts.***

The schools we visited illustrate what can be done to engage students and provide them with current and often unique information with unprecedented speed and convenience. If used well, the Internet brings the world into the classroom. Demonstrations and simulations can make abstract concepts tangible. Computers provide immediate feedback on tasks and engage students in new ways of learning. Email and electronic bulletin boards facilitate communication among teachers, students, and parents. In a select number of CPS schools, a critical mass of teachers is using technology in meaningful and innovative ways. These schools have done so by making technology integration a priority and mobilizing all their resources to realize this vision. Can we ask this of every school in a struggling urban district? Currently, elementary schools that are predominantly African American and high schools on probation show lower levels of technology access for students and teachers. It will be difficult for many of these schools to justify allocating large portions of their budget to new technology. Without a change in district policy, most are unlikely to raise their current levels of access and use.

In this report, we identify two major steps in creating good technology programs: adequate resources (i.e., hardware and human resource support), and developing teachers' individual capacity to use technology well. The typical CPS school has yet to overcome the first obstacle. They must not only find funding to purchase hardware, but also ensure that technical assistance and upgrades will be available. The scarcity of computing resources in CPS high schools may be lessening with the Board's new initiative to provide laptops for teachers and administrators and to establish networks in schools, but a one-time infusion of hardware will not be sufficient to bring about truly integrated technology use on a systemwide level.

Even though there is limited technology use in most CPS schools, those teachers who are able to use it in meaningful ways are scattered; only a few schools are able to boast a critical mass of teachers who are maximizing technology's potential in the

*In this report, we identify two major steps in creating good technology programs: adequate resources (i.e., hardware and human resource support), and developing teachers' individual capacity to use technology well. The typical CPS school has yet to overcome the first obstacle.*

classroom. Many new teachers are entering schools with knowledge of how to use computers for their own work, but they have not been prepared to integrate it into assignment. Some experienced teachers do encourage students to use technology, but they are not entirely comfortable with the tasks they are asking their students to do. Once schools have a sufficient number of reliable computers for students and teachers, they must develop the capacity of their teachers.

Building on previous Consortium research on the necessary organizational supports for quality professional development, we find that teachers require (1) time to participate in training and to evaluate new ideas; (2) principal leadership to provide goals and secure resources; and (3) a professional community where teachers can collaborate and learn together.[46] We find that teachers appreciate professional development that produces classroom-ready lessons so that evaluating and working through new skills can take place at the same time. Many teachers also prefer professional development that models techniques in the classroom and encourages interaction and collaboration among colleagues. Additionally, the presence of an expert at the school who is knowledgeable about technology's capabilities and how it can aid in instruction can greatly facilitate teachers' adoption of new practices. A technical coordinator provides many kinds of support to teachers—from ensuring reliable access to working hardware and software, to identifying quality professional develop opportunities, to serving as an advisor before, during, and after implementation.

Neither of these obstacles will be overcome, however, if school and district leadership is not committed to the goal of creating technology-rich learning environments for CPS students. If the district fails to commit to this goal, it will be up to individual principals and LSCs to see that their schools get the resources and support their students and teachers need. The major challenge the district faces is to ensure that technology development takes place in all schools in the system. The major challenge principals and LSCs face is to ensure that development happens throughout their schools.

# Appendix A
## *Further Details on the Methods Used in Analyses*

## SURVEY PARTICIPANTS

**Students:** We collected surveys from 59,663 elementary and 28,069 high school students and used them in our analyses. This represents 59 percent of all students in grades six through ten. Of these students, 51 percent were female; 45 percent were African American; 38 percent were Latino; 4 percent were Asian; and 12 percent were white.

**Teachers:** We collected surveys from 8,572 elementary and 2,642 high school teachers and used them in our analyses. All teachers were surveyed, regardless of grade taught. Of these teachers, 79 percent were female; 31 percent were African American; 12 percent were Latino; 2 percent were Asian; and 48 percent were white. Fifty-eight percent had earned a degree past a bachelor's. Six percent were new to teaching (less than one year) and 46 percent had been teaching for more than 15 years. Twenty-five percent taught pre-kindergarten to second grade, 24 percent taught grades three through five; 41 percent taught grades six through 10 (grades in which students were surveyed); 7 percent taught grades 11 and 12; and 3 percent taught ungraded classrooms. Twenty-five percent more did not identify the grade they taught.

**Schools:** Surveys were sent to 577 schools, of which 434 participated (75 percent). Only a small number of schools were excluded from the survey. These included alternative schools and child care centers.

## FIELD SCHOOLS

A list of potential field schools was developed by selecting elementary schools that scored in the top quartile on four of our measures of technology availability and use (teachers' professional use of technology, teachers' assignment of technology, having a computer in the classroom, and using a computer daily or almost daily at school). Because our survey measures indicate quantity of use but not quality, we also consulted a number of experts with experience working on technology in CPS. These included individuals at CPS working with the Technology Infusion Planning (TIP), other researchers doing fieldwork in schools and members of groups such as CUIP (Chicago Public Schools and University of Chicago Internet Project) and LeTUS (the Center for Learning Technologies in Urban Schools) that were working with CPS schools to develop technology programs. We chose schools from different regions when making our final selections. One school declined to participate due to scheduling conflicts.

# MEASURES USED IN ANALYSIS

*All measures were constructed using Rasch scaling methods.*

## Students

**Students Attitudes Toward Technology.** Students' belief that use of computers or the Internet will benefit them in terms of preparing them for the workforce, assisting them with class work and adding to their enjoyment of class. *Individual reliability = 0.78; school reliability = 0.54.*

Items are answered on a four-point, strongly disagree to strongly agree scale:

- Learning how to use computers and the Internet will help me get a job.
- Learning how to use computers and the Internet helps me do better in my classes.
- Using computers and the Internet makes class work more fun.

| Category | Students |
|---|---|
| **Very positive** | strongly agree that learning computers will help them get a job and do better in their classes and that computers make class work more fun. |
| **Positive** | agree with all items. |
| **Negative** | disagree with all items. |
| **Very negative** | strongly disagree with all items. |

**Access to Computers.** Access to computers measures the extent to which students report computer hardware is available to them. A high score indicates greater availability. *Individual reliability = 0.44; school reliability = 0.88.*

Items are answered on a four-point, strongly disagree to strongly agree scale:

- At school I can usually find an available computer to use for homework.
- My school has enough computers for students to use.

| Category | Students |
|---|---|
| **Ample** | strongly agree with both items |
| **Positive** | agree with both items. |
| **Negative** | disagree with both items. |
| **Very negative** | strongly disagree with both items. |

**Student Use of Technology.** Student use of technology measures the extent to which students report using a computer at school for various activities including practice drills, word processing, research on the Internet and creating presentations. A high score indicates more frequent and diverse use of technology in school. *Individual reliability = 0.67; school reliability = 0.90.*

This school year, how often do you use a computer AT SCHOOL for the following things? *(Never, Once or Twice a Semester, Once or Twice a Month, Once or Twice a Week, Almost Every Day)*

- Practice drills (for example, math problems, vocabulary, spelling)
- Analyze or graph data (in Excel, for example)
- Word processing or typing (in Word, for example)
- Create presentations (in Power Point, for example)
- Create web pages
- Computer programming
- Do research using the Internet
- Correspond with others via email or the Internet

| **Category** | **Students** |
|---|---|
| **Very intensive** | use a computer or the Internet at school for basic and more advanced activities daily and the most advanced tasks at least once or twice a week. |
| **Intensive** | perform basic tasks daily and more advanced tasks, such as creating presentations and analyzing or graphing data, weekly. |
| **Moderate** | perform basic tasks once or twice a week and more advanced tasks once or twice a semester. |
| **Limited** | use a computer or the Internet to perform basic tasks such as word processing or research from once or twice a semester to once or twice a month; more advanced activities are never performed. |
| **None** | never use a computer or the Internet at school to do any of these activities. |

**Technology Use Across the Curriculum.** Technology use across the curriculum measures to what extent students use technology in English, Social Studies/History, Math and Science classes. A higher score indicates more frequent use in a larger number of classes. *Individual reliability = 0.66; school reliability = 0.85.*

This school year, how often do you use a computer AT SCHOOL for the following things? *(Never, Once or Twice a Semester, Once or Twice a Month, Once or Twice a Week, Almost Every Day.)*

- Work on an assignment for Reading/Language Arts class
- Work on an assignment for Math class
- Work on an assignment for Science class
- Work on an assignment for Social Studies or History class

| **Category** | **Students** |
|---|---|
| **Daily** | use technology daily in all core classes. |
| **Frequent** | use technology weekly in most core classes. |
| **Infrequent** | occasionally use technology in core classes. |
| **Never** | never use technology in any core classes. |

**Students' Home Use of Technology.** Home use of technology measures students' availability and use of home computers. *Individual reliability = 0.65; school reliability = 0.53.*

- Which of the following does your family have in your home? A computer
- Which of the following does your family have in your home? Internet access
- This school year, how often have you used a computer in the following places? At home *(Never, Once or Twice a Semester, Once or Twice a Month, Once or Twice a Week, Almost Every Day)*

## TEACHERS

**Teacher Attitudes Toward Technology.** Teachers' attitudes toward technology measures teachers' belief that technology is beneficial for teaching critical thinking and job skills and is a good way to engage students with project-based learning in a real world context. *Individual reliability = 0.80; school reliability = 0.21.*

Items are answered on a four-point, strongly disagree to strongly agree scale:

**Computing technology…**

- Should be used to raise standardized test scores.
- Plays only a small role in strengthening students' basic academic skills.
- Skills are critical in preparing students for the work force.
- Should be used to develop students' critical thinkingand problem solving skills.
- Skills are essential in only a small number of specialized jobs in the work force.
- Provides real-world context for learning.
- Can be used to facilitate project-based learning.
- Is a good way to engage student attention.

| Category | Teachers |
|---|---|
| **Very positive** | Agree that computing technology should be used in strengthening basic skills and raising test scores. They strongly agree with all other items. |
| **Positive** | Some disagree and others plays a role in strengthening basic skills and should be used to raise standardized test scores. Teachers agree that computing technology engages students and should be used to develop critical thinking. They agree or strongly agree that it prepares students for future jobs. |
| **Negative** | While some agree, most disagree or strongly disagree that computing technology prepares students for future jobs. Teachers disagree or strongly disagree with all other items. |

**Availability of Technology.** Hardware availability measures the extent to which teachers are able to use technology hardware including computers, the Internet and email in their schools and classrooms. Higher scores indicate more extensive availability of technology for teachers. *Individual reliability = 0.36; school reliability = 0.88.*

Are the following available to you, and if yes, how often do you use them? *(Never, Once or Twice a Semester, Once or Twice a Month, Once or Twice a Week, Daily or Almost Daily)*

- Computer in your classroom
- Computer elsewhere in the school
- Internet in the classroom
- Internet elsewhere in the school
- Email in your classroom
- Email elsewhere in the school

| Category | Teachers |
|---|---|
| **Excellent** | have computers in the classrooms that are wired to the Internet. |
| **Good** | are wired to the Internet somewhere in the school and have computers in their classrooms. |
| **Basic** | have access to a computer in the school, and are wired to the Internet, but do not have computers n the classroom. |
| **None** | may or may not have access to a computer in the school but are not wired to the Internet. |

**Teacher Use of Technology.** Teachers' use of technology measures how frequently teachers use technology in their own work. Activities include creating instructional material, accessing model lesson plans, and creating multimedia presentations. A high score indicates more frequent and diverse use of technology. *Individual reliability = 0.80; school reliability = 0.53.*

For each activity below, please indicate how often you use computers or the Internet to complete the activity. *(Never, Once or Twice a Semester, Once or Twice a Month, Once or Twice a Week, Daily or Almost Daily)*

- Create instructional materials (i.e., handouts, tests, etc.)
- Gather information for planning lessons
- Access model lesson plans
- Access research and best practices for teaching
- Access the CPS Intranet
- Create multimedia presentations for the classroom

| Category | Teachers |
|---|---|
| **Highly intensive** | perform most activities with technology daily and create multimedia presentations weekly to daily. |
| **Intensive** | regularly use technology for basic tasks and access information, such as best practices, weekly; some also create multimedia presentations weekly. |

| | |
|---|---|
| **Limited** | use technology for basic tasks up to once a week; they also use technology to access model lesson plans and best practices for teaching up to once or twice a month; some also occasionally create multimedia presentations for the classroom. |
| **None** | never or seldom use technology; those that do make instructional material or gather information for planning lessons once or twice a semester or once or twice a month. |

**Teacher Assignment of Technology.** Teacher assignment of technology in the classroom measures teachers' assessment of how frequently they include various uses of technology in their assignments. Activities include practice drills, word processing, creating presentations and research on the Internet. A high score indicates more frequent and diverse use of technology. *Individual reliability = 0.70; school reliability = 0.49.*

For each activity below, please indicate how often you use computers or the Internet to complete the activity. *(Never, Once or Twice a Semester, Once or Twice a Month, Once or Twice a Week, Daily or Almost Daily)*

- Practice drills
- Analyze or graph data
- Do word processing or typing
- Create presentations
- Create web pages
- Computer programming
- Do research using the Internet
- Correspond with others via email or Internet
- Do demonstrations/simulations

| **Category** | **Teachers** |
|---|---|
| **Highly integrated** | assign basic to moderate tasks on a weekly to daily basis; more complex activities such as demonstrations, email, computer programming and web page creation are assigned anywhere from once or twice a semester to daily. |
| **Integrated** | assign basic tasks as much as once or twice a week and moderately uncommon tasks, such as analyzing or graphing data and creating presentations, from once or twice a semester or once or twice a month; some occasionally assign using technology for demonstrations or email. |
| **Modest** | assign basic tasks once or twice a semester to once or twice a month. Most also assign moderately uncommon tasks up to once or twice a month but do not assign more complex tasks such as demonstrations. |
| **Limited** | assign low level tasks like word processing, practice drills and research on the Internet from once or twice a semester to once or twice a month. Never assign any more complex tasks. |
| **None** | never assign technology to students in their target class. |

**Teacher Home Use of Technology.** Teacher home use is a measure of the extent to which teachers have and use computers, the Internet or email at home. A high score indicates greater use of technology at home. *Individual reliability = 0.76; school reliability = 0.003.*

Are the following available to you, and if yes, how often do you use them? *(Never, Once or Twice a Semester, Once or Twice a Month, Once or Twice a Week, Daily or Almost Daily)*

- Computer at home
- Internet at home
- Email at home

**Human Resource Support for Technology.** Human resource support for technology measures the amount of basic support teachers find for their technology use including access to a technology coordinator, working computers, and support for curriculum integration and trouble-shooting. *Individual reliability = 0.79; school reliability = 0.82.*

Items are answered on a four-point, strongly disagree to strongly agree scale:

- Our school's technology coordinator helps teachers integrate computing technology into lessons.
- I can find help in my school when I have trouble using computing technology.
- The computing technology in my school is in good working order.

Please indicate the extent, if any, each of the following are barriers to your use of school computers or the Internet for instruction. *(Not a Barrier, Small Barrier, Moderate Barrier, Great Barrier)*

- Lack of technology coordinator in school.

| Category | Teachers |
|---|---|
| **Very strong** | strongly agree with all the items. |
| **Strong** | can find help when they have trouble and their technology coordinator can help them with integrating technology into lessons; they agree that computers are in good working order. |
| **Weak** | can find some technical support for technology use, but report that the lack of a technology coordinator to be a small or moderate barrier; some teachers agree and others disagree that their computers are in good working order. |
| **None** | lack support for technology use; they describe a lack of a technology coordinator as a great barrier and cannot find help when they have trouble using technology; they disagree that their computers are in good working order. |

**Professional Community Around Technology.** Measures the general willingness of the teachers in a school to support technology integration. *Individual reliability = 0.72; school reliability = 0.52.*

Please indicate the extent, if any, each of the following are barriers to your use of school computers or the Internet for instruction. *(Not a Barrier, Small Barrier, Moderate Barrier, Great Barrier)*

- Lack of teacher agreement that integrating technology into lessons is important.
- Reluctance among teachers to take professional development about integrating technology into lessons.
- Lack of teacher support.

| **Category** | **Teachers** |
|---|---|
| **Very strong** | do not find any of these factors to be barriers to technology use. |
| **Strong** | describe lack of teacher agreement regarding technology's importance and their reluctance to take professional development in technology as small barriers; general lack of teacher support was not a barrier to technology use. |
| **Weak** | describe lack of teacher agreement regarding technology's importance and their reluctance to take professional development in technology as moderate barriers to technology use. |
| **Very weak** | describe lack of teacher agreement regarding technology's importance and their reluctance to take professional development in technology as great barriers; general lack of teacher support was described as a moderate barrier to technology use. |

**Professional Development for Technology.** Measures the extent to which a teacher is aware of and participating in professional development regarding use of technology in the classroom. A high score indicates that a teacher has been able to find and take advantage of professional development opportunities in technology use. *Individual reliability = 0.79; school reliability = 0.62.*

Items are answered on a four-point, strongly disagree to strongly agree scale:

- I am aware of professional development that could enhance my ability to use computing technology in classroom instruction.
- I have taken professional development that enhances my ability to use computing technology in classroom instruction.
- The professional development available to me is relevant to how I believe computers should be used in the classroom.
- I have tried to take advantage of computing technology training, but was not able to do so because of circumstances outside of my control (access, cost, etc.).

Please indicate the extent, if any, each of the following are barriers to your use of school computers or the Internet for instruction. *(Not a Barrier, Small Barrier, Moderate Barrier, Great Barrier):*

- Lack of release time to learn/practice/plan ways to use computers or the Internet.
- Lack of appropriate professional development on how to integrate computing technology into curriculum.

| Category | Teachers |
|---|---|
| **Very strong** | strongly agree with all items and find lack of professional developmentand release time not to be barriers at all. |
| **Strong** | agree that they are aware of and have taken professional development that they found relevant to their use of computers in the classroom; lack of both professional development and release time are described as small to moderate barriers. |
| **Weak** | most disagree but some agree that they are aware of professional development opportunities for technology use; they disagree or strongly disagree with all other items and find lack of both professional development and release time to be great barriers to technology use. |
| **Very weak** | strongly disagree with items regarding the availability and usefulness of professional development for technology; they describe lack of both professional development and release time for learning and planning to be great barriers to technology use. |

**Principal Support for Technology.** Measures teachers' perception of how much support the principal has given to the use of technology for classroom instruction. A high score indicates greater principal support. *Individual reliability = 0.01; school reliability = 0.74.*

Items are answered on a four-point, strongly disagree to strongly agree scale:

- The principle encourages teachers to take professional development on how to integrate omputers and the Internet into classroom instruction.

Please indicate the extent, if any, each of the following are barriers to your use of school computers or the Internet for instruction. *(Not a Barrier, Small Barrier, Moderate Barrier, Great Barrier)*

- Lack of principal support.

| Category | Teachers |
|---|---|
| **Strong support** | strongly agree that the principal encourages professional development in technology, and consider lack of principal support not a barrier. |
| **Some support** | agree that the principal encourages professional development in technology; most find lack of principal support not a barrier. |
| **Mixed** | either agree or disagree that the principal encourages professional development in technology; they describe lack of principal supportas a moderate or small barrier. |
| **Negative** | disagree and strongly disagree that the principal encourages them to participate in professional development or to integrate technology into instruction; they describe the lack of principal support as a great barrier to using technology in instruction. |

# Appendix B
## *Details of Equity Analyses*

Equity analyses were designed to determine whether there were differences in technology use or access between students, teachers, and schools that had different demographic characteristics. For each technology outcome measure, four series of analyses were performed, all using three-level hierarchical linear models. In each equation, the first level was a measurement model, which determined the most accurate estimation of each person's score on the technology measure, given their standard error on the measure (determined through Rasch analysis by their response pattern to the items in the question). The second level modeled individual-level characteristics of students or teachers, while the third level compared schools.

Each series was initially run separately for elementary and high schools. However, because the individual-level patterns were similar at both levels, elementary and high school responses were combined for the equations modeling individual-level group differences. School-level patterns were different among elementary and high schools, so separate school-level results are presented.

## SERIES 1

The first series of equations explored whether there were differences in technology use or access across the system based on students' and teachers' personal demographic characteristics, without regard for other variables. For example, "Are African-American students in CPS using technology more or less in school than students of other races? Are CPS teachers with more experience more likely to have access to computing technology than newer teachers?"

Each characteristic of individuals (students or teachers) was studied by itself at Level 2, fixed across schools, so that the coefficient/s would represent total differences between groups across the system:

**Level-1 Models (Measurement Models)**

$Y = \Pi_1*(WGT) + e$

**Level-2 Models (Student or Teacher Models)**

$\Pi_1 = B_{10} + B_{12} \ldots B_{1j}$ (Individual Level Group Dummy variables) $+ r_1$

**Level-3 Models (School Models)**

$B_{10} = \gamma_{100} + u_{10}$

$B_{12} = \gamma_{120} \ldots B_{1j} = \gamma_{1j0}$

Dummy variables representing the groups defining each characteristic were entered simultaneously (e.g., dummy variables for African American, white, Latino entered together to study race), but no other variables at Level 2 were included, with the exception of grade level and subject area. Dummy variables representing grade level (both students and teachers), and subject area (teachers) were entered as control variables for equations modeling all other characteristics, since these were structural characteristics that might have biased analyses of demographic differences.

This series of analyses was used to create the individual-level boxplot charts in Chapter 3 that show differences among groups of students and teachers. The coefficients of the individual-level characteristics provided the information used to calculate the difference of each group from the system mean.

One final model was run for each measure to determine whether any differences found between groups remained after controlling for other individual-level characteristics. The models were the same, except that all student- or teacher-level characteristics were entered simultaneously at Level 2. The individual-level characteristics were grand-mean centered to discern differences across the system. No substantial differences were found when other characteristics were controlled.

## SERIES 2

The second series of models examined whether the individual characteristics studied in Series 1 showed different patterns within schools than across the system. For example, "Do low achieving students tend to use technology less than high achieving students who are in the same school?"

These models were the same as those in Series 1, but the individual characteristics were group-mean centered, instead of grand-mean centered. No substantial differences were found, compared to Series 1.

## SERIES 3

The third series of analyses examined differences in technology use and access between different types of schools. For example, "Do high poverty schools report less availability of technology than low poverty schools?"

In this series, each school characteristic (racial composition, average achievement level, percent low-income students), was entered separately at Level 3 with dummy variables representing the groups defined by that characteristic. At Level 2, only controls for grade level were entered (grand-mean centered), to adjust for differences in the grade levels served by each school:

**Level-1 Models (Measurement Models)**

$Y = \Pi_1 * (WGT) + e$

**Level-2 Models (Student or Teacher Models)**

$\Pi_1 = B_{10} + B_{12} \ldots B_{1j}$ (Grade Level Dummies) $+ r_1$

**Level-3 Models (School Models)**

$B_{10} = \gamma_{100} + \gamma_{101} \ldots \gamma_{10k}$ (School Characteristic Dummies) $+ u_{10}$

$B_{20} = \gamma_{200} \ldots B_{1j} = \gamma_{1j0}$

These analyses provided information for the school-level equity displays presented in Chapter 3. Each coefficient representing a school characteristic provided information on the difference of each group from the system mean.

## SERIES 4

One final model was run for each technology measure that included all individual-level variables at Level 2, grand-mean centered, and all school-level variables entered simultaneously at Level 3. These final models allowed us to discern whether school differences found in Series 3 could be explained by other school-level characteristics, or by the composition of students/teachers in the school. For example, "Do selective high schools show greater teacher assignment of technology because they are composed of higher achieving students, or because of some unique structural characteristic of selective high schools?"

We found that many of the differences in technology use and access found between groups of schools could be attributed to differences in the composition of students/teachers in the schools.

# Appendix C
## *Details of Essential Support Analyses*

Each portion of our model describing factors that affect technology use in schools was tested using three-level hierarchical linear models. In each equation, Level 1 was a measurement model that weighted individual scores by the standard error in that person's measure. Because these measures were developed through Rasch analysis, each score had an associated standard error based on the response pattern of the respondent. The measurement model allowed for better estimation of the true relationships of the predictors with the dependent variable. Individual student or teacher variables were entered at Level 2, and school variables were entered at Level 3. For each series of equations that predict student or teacher use of technology, the contribution of demographic and technology variables to the explanation of use are presented in summary tables below. The final models predicting other technology variables (technology availability, professional development in technology, availability of human resource support in technology) are also presented to show the relationships among those other variables.

*Table A1: Equations Predicting Student Use of Technology in School*

| Elementary Schools | Level 2 Variance | Percent Explained | Level 3 Variance | Percent Explained |
|---|---|---|---|---|
| Unconditional model | 2.21 | | 0.81 | |
| Models with level-2 predictor variables added to previous model: | | | | |
| Person-level demographic controls[1] | | 4.57 | | 2.10 |
| Student's home use of technology | | 5.86 | | 2.16 |
| Student's beliefs about technology | | 10.36 | | 10.31 |
| Models with level-2 predictor variables added to previous model: | | | | |
| School-level demographic controls[2] | | 10.36 | | 13.28 |
| Availability of technology at school for students | | 10.30 | | 58.46 |
| Teacher assignment of technology | | 10.32 | | 62.71 |
| **High Schools** | **Level 2 Variance** | **Percent Explained** | **Level 3 Variance** | **Percent Explained** |
| Unconditional model | 1.52 | | 0.45 | |
| Models with level-2 predictor variables added to previous model: | | | | |
| Person-level demographic controls[1] | | 4.60 | | 6.18 |
| Student's home use of technology | | 5.65 | | 6.63 |
| Student's beliefs about technology | | 11.64 | | 12.17 |
| Models with level-2 predictor variables added to previous model: | | | | |
| School-level demographic controls[2] | | 11.64 | | 17.38 |
| Availability of technology at school for students | | 11.62 | | 50.06 |
| Teacher assignment of technology | | 11.61 | | 57.89 |

[1] *Person-level demographic controls include: gender, race (White, Latino, African American, other), grade level (separate variable for each grade), special education marker, bilingual education marker, poverty indicator (percent of males unemployed and percent of residents below the poverty line in student's census block group), social status indicator (mean income and percent of males employed as managers/professionals in student's census block group), summer school marker, mother's education level, reading score on ITBS or TAP, math score on ITBS or TAP.*

[2] *School-level demographic controls include: racial composition of the school (over 85 percent African American, over 85 percent Latino, over 30 percent white, less than 30 percent white but not predominantly African-American or Latino), and a marker for over 90 percent low income. Elementary school controls include variables differentiating schools on probation (less than 20 percent of students at norms), near probation (20 to 35 percent of students at norms), not near probation (35 to 50 percent at norms), and high achievement (50 percent or more at norms). High school controls included markers differentiating selective schools, probation schools, and other schools (neighborhood and technical).*

| *Table A2: Equations Predicting Teacher Assignment of Technology to Students* | | | | |
|---|---|---|---|---|
| **Elementary Schools** | **Level 2 Variance** | **Percent Explained** | **Level 3 Variance** | **Percent Explained** |
| Unconditional model | 2.36 | | 0.32 | |
| Models with level-2 predictor variables added to previous model: | | | | |
| Person-Level Demographic Controls[1] | | 14.24 | | 0.31 |
| Teacher's use of technology for their own professional work | | 31.36 | | 41.69 |
| Professional development in technology | | 32.3 | | 50.16 |
| Home use of technology and beliefs about technology | | 33.1 | | 49.84 |
| Models with level-2 predictor variables added to previous model: | | | | |
| School-level demographic controls[2] | | 33.90 | | 59.25 |
| Availability of technology at school for teachers | | 33.47 | | 73.67 |
| Availability of technology at school for students | | 33.18 | | 77.43 |
| Human resource support in technology | | 33.05 | | 80.75 |
| Professional community around technology and Principal support for technology | | 33.05 | | 80.56 |
| **High Schools** | **Level 2 Variance** | **Percent Explained** | **Level 3 Variance** | **Percent Explained** |
| Unconditional model | 2.44 | | 0.13 | |
| Models with level-2 predictor variables added to previous model: | | | | |
| Person-level demographic controls[1] | | 5.74 | | 0.0 |
| Teacher's use of technology for their own professional work | | 27.66 | | 60.94 |
| Professional development in technology | | 29.10 | | 74.22 |
| Home use of technology and beliefs about technology | | 30.33 | | 69.53 |
| Models with level-3 predictor variables added to previous model: | | | | |
| School-level demographic controls[2] | | 30.90 | | 100.00 |
| Availability of technology at school for teachers, Availability of technology at school for students, Human resource support in technology, Professional community around technology, Principal support for technology[3] | | 29.50 | | 100.00 |

*[1] Person-level demographic controls include: gender, race (white, Latino, African American, other), grade level taught (elementary teachers only: pre-k/ungraded, primary, middle, grades seven to eight), experience (less than three years; more than three years), master's degree marker, self-contained marker, vocational education marker.*

*[2] School-level demographic controls include: Racial composition of the school (over 85 percent African American, over 85 percent Latino, over 30 percent white, less than 30 percent white but not predominantly African-American or Latino), and a marker for over 90 percent low income. Elementary school controls included variables differentiating schools on probation (less than 20 percent of students at norms), near probation (20 to 35 percent of students at norms), not near probation (35 to 50 percent at norms), and high achievement (50 percent or more at norms). High school controls included markers differentiating selective schools, probation schools, and other schools (neighborhood and technical).*

*[3] At the high school level, almost no variance is left to be explained by technology variables once demographic controls are included (especially the dummy variables for selective and probation schools). The selective high schools are substantially higher than other schools on all technology measures, including teachers' assignment of technology, while schools on probation are substantially lower on these measures.*

*Table A3: Equations Predicting Teachers' Professional Use of Technology for their Own Work*

| Elementary Schools | Level 2 Variance | Percent Explained | Level 3 Variance | Percent Explained |
|---|---|---|---|---|
| Unconditional model | 2.21 | | 0.26 | |
| Models with level-2 predictor variables added to previous model: | | | | |
| Person-level demographic controls[1] | | 4.89 | | 6.64 |
| Teacher's computer use at home | | 18.03 | | 21.37 |
| Professional development in technology | | 23.00 | | 40.84 |
| Beliefs about technology | | 26.18 | | 41.60 |
| Models with level-3 predictor variables added to previous model: | | | | |
| School-level demographic controls[2] | | 26.18 | | 43.13 |
| Availability of technology at school for teachers | | 26.18 | | 68.85 |
| Human resource support in technology, Professional community around technology, Principal support for technology | | 26.18 | | 70.61 |
| **High Schools** | **Level 2 Variance** | **Percent Explained** | **Level 3 Variance** | **Percent Explained** |
| Unconditional model | 2.25 | | 0.19 | |
| Models with level-2 predictor variables added to previous model: | | | | |
| Person-level demographic controls[1] | | 4.85 | | 8.85 |
| Teacher's computer use at home | | 14.18 | | 27.61 |
| Professional development in technology | | 22.85 | | 63.00 |
| Beliefs about technology | | 27.52 | | 65.15 |
| Models with level-3 predictor variables added to previous model: | | | | |
| School-level demographic controls[2] | | 27.70 | | 73.46 |
| Availability of technology at school for teachers | | 27.52 | | 86.60 |
| Human resource support in technology, Professional community around technology, Principal support for technology | | 27.52 | | 91.96 |

*[1] Person-level demographic controls include: gender, race (white, Latino, African American, other), grade level taught (elementary teachers only: pre-k/ungraded, primary, middle, grades seven to eight), experience (less than three years, more than three years), master's degree marker, self-contained marker, vocational education marker.*

*[2] School-level demographic controls include: racial composition of the school (over 85 percent African American, over 85 percent Latino, over 30 percent white, less than 30 percent white but not predominantly African American or Latino), and a marker for over 90 percent low income. Elementary school controls included variables differentiating schools on probation (less than 20 percent of students at norms), near probation (20 to 35 percent of students at norms), not near probation (35 to 50 percent at norms), and high achievement (50 percent or more at norms). High school controls included markers differentiating selective schools, probation schools, and other schools (neighborhood and technical).*

*Table A4: Final Equation Predicting Availability of Technology for Teachers, Elementary Schools*

| School-Level Predictors of the Intercept | | Coefficient | p-level |
|---|---|---|---|
| | Intercept | 4.981 | 0.000 |
| Technology measures | Professional community around technology | 0.215 | 0.093 |
| | Human resource support for technology | 0.752 | 0.000 |
| | Principal support for technology | 0.543 | 0.001 |
| School demographics | Predominantly African American (comparison: mixed minority) | -0.855 | 0.002 |
| | Predominantly Latino (comparison: mixed minority) | 0.083 | 0.805 |
| | Integrated (comparison: mixed minority) | -0.277 | 0.466 |
| | Over 90 percent low income (comparison: under 90 percent) | 0.081 | 0.739 |
| | On probation (comparison: middle achieving) | -0.046 | 0.925 |
| | Near probation (comparison: middle achieving) | -0.380 | 0.297 |
| | High achieving (comparison: middle achieving) | -0.334 | 0.338 |
| **Person-Level Predictors of the Intercept** | | **Coefficient** | **p-level** |
| | Teachers' home use of technology | 0.038 | 0.002 |
| Individual demographics | Three or more years' experience (comparison: less than three years) | 0.408 | 0.001 |
| | Dummy: teacher experience unknown | 0.303 | 0.108 |
| | African American (comparison: white) | 0.237 | 0.008 |
| | Latino (comparison: white) | 0.048 | 0.717 |
| | Other race (comparison: white) | -0.073 | 0.578 |
| | Race unknown | 0.156 | 0.347 |
| | Male (comparison: female) | -0.022 | 0.827 |
| | Master's degree (comparison: no master's) | -0.031 | 0.659 |
| | Education unknown | -0.337 | 0.135 |
| | Pre-K or ungraded classroom (comparison: primary grade) | -0.311 | 0.035 |
| | Middle grade (comparison: primary grade) | 0.367 | 0.001 |
| | Jr. high grade (comparison: primary grade) | 0.614 | 0.000 |
| | Self-contained classroom (comparison: other subject area) | 0.110 | 0.189 |
| | Vocational/tech teacher (comparison: other subject area) | 2.391 | 0.000 |
| | Grade level unknown | 0.430 | 0.002 |

| *Table A5: Final Equation Predicting Professional Development Among Teachers, Elementary Schools* | | | |
|---|---|---|---|
| **School-Level Predictors** | | **Coefficient** | **p-level** |
| | Intercept | 4.024 | 0.000 |
| **Technology measures** | Professional community around technology | 0.151 | 0.000 |
| | Human resource support for technology | 0.145 | 0.000 |
| | Principal support for technology | 0.250 | 0.000 |
| **School demographics** | Predominantly African American (comparison: mixed minority) | -0.009 | 0.881 |
| | Predominantly Latino (comparison: mixed minority) | 0.020 | 0.795 |
| | Integrated (comparison: mixed minority) | -0.045 | 0.552 |
| | Over 90 percent low income (comparison: under 90 percent) | 0.047 | 0.429 |
| | On probation (comparison: middle achieving) | -0.083 | 0.438 |
| | Near probation (comparison: middle achieving) | -0.047 | 0.578 |
| | High achieving (comparison: middle achieving) | 0.013 | 0.854 |
| **Person-Level Predictors of the Intercept** | | **Coefficient** | **p-level** |
| | Teachers' home use of technology | 0.074 | 0.000 |
| **Individual demographics** | Three or more years' experience (comparison: less than three years) | 0.048 | 0.414 |
| | Dummy: teacher experience unknown | 0.057 | 0.599 |
| | African American (comparison: white) | 0.359 | 0.000 |
| | Latino (comparison: white) | -0.126 | 0.072 |
| | Other race (comparison: white) | 0.011 | 0.894 |
| | Race unknown | 0.048 | 0.625 |
| | Male (comparison: female) | -0.018 | 0.743 |
| | Master's degree (comparison: no master's) | 0.094 | 0.024 |
| | Education unknown | -0.145 | 0.281 |
| | Pre-K or ungraded classroom (comparison: primary grade) | 0.228 | 0.009 |
| | Middle grade (comparison: primary grade) | 0.034 | 0.535 |
| | Jr. high grade (comparison: primary grade) | 0.022 | 0.727 |
| | Self-contained classroom (comparison: other subject area) | -0.150 | 0.002 |
| | Vocational/tech teacher (comparison: other subject area) | 1.102 | 0.000 |
| | Grade level unknown | 0.041 | 0.554 |

ERRATA

Series 1 models on page 69 should read:

**Level-1 Models (Measurement Models)**
$Y_{ijk} = \pi_{1jk}(WGT_{ijk}) + e_{ijk}$

**Level-2 Models (Student or Teacher Models, example is for grade level. Other characteristics were modeled in the same way.)**
$\pi_{1jk} = \beta_{10k} + \beta_{11k}(\text{Grade } 7_{jk}) + \beta_{12k}(\text{Grade } 8_{jk}) + \beta_{13k}(\text{Grade } 9_{jk}) + \beta_{14k}(\text{Grade } 10_{jk}) + r_{1jk}$

**Level-3 Models (School Models)**
$\beta_{10k} = \gamma_{100} + u_{10k}$
$\beta_{11k} = \gamma_{110}$
$\beta_{12k} = \gamma_{120}$
$\beta_{13k} = \gamma_{130}$
$\beta_{14k} = \gamma_{140}$

Series 3 models on page 71 should read:

**Level-1 Models (Measurement Models)**
$Y_{ijk} = \pi_{1jk}(WGT_{ijk}) + e_{ijk}$

**Level-2 Models (Student or Teacher Models, example is for elementary schools. High school models were the same, but with grades 9 and 10 instead of 6, 7, and 8.)**
$\pi_{1jk} = \beta_{10k} + \beta_{11k}(\text{Grade } 7_{jk}) + \beta_{12k}(\text{Grade } 8_{jk}) + r_{1jk}$

**Level-3 Models (School Models, example is for school achievement. Other school-level characteristics were modeled in the same way.)**
$\beta_{10k} = \gamma_{100} + \gamma_{101}\text{ (selective admissions dummy}_k) + \gamma_{102}\text{ (probation dummy}_k) + u_{10k}$
$\beta_{11k} = \gamma_{110}$
$\beta_{12k} = \gamma_{120}$

# Endnotes

1 NCES (2001).

2 Dwyer (1996); Kulick (1994); and Jonassen and Reeves (1996).

3 Author, Levy, and Murnane (2001), 39-40.

4 Thornburg (1998).

5 Woodward and Gridina (2000), 12.

6 Becker (2000), 55.

7 Means, Penuel and Padilla (2000), 4.

8 Wenglinsky (1998).

9 CEO Forum (1999).

10 Cuban (2001), 171.

11 Glennan and Melmed (2000), 69.

12 For simplicity's sake, we will use technology as shorthand for educational computing technology. By this we mean educational uses of computers, computer peripherals, the Internet, and computer software.

13 Although our teacher measure of technology assignment parallels the student measure of technology use with respect to the activities listed, there is one important difference. Students were asked to report on technology use at school for any class or any purpose (clubs, personal use, etc). Teachers, on the other hand, were asked about assignments for one particular class, regardless of whether students completed that assignment at school, home, or another location. Therefore, although the measures use the same items,their scope differs and so they arenot directly comparable.

14 The low levels of teacher technology assignment did not result simply because most teachers responding to the survey were in the lower grades. Forty-one percent of teachers responding to the survey taught grades six through ten (the grades students were surveyed), and the assignment of technology among these teachers was almost exactly the same as the levels of technology assignment among all teachers combined.

15 Smerdon, et al. (2000).

16 US Department of Commerce (1999), xiii.

17 Ibid.

18 A school is defined as predominantly low income if more than 90 percent of students are eligible for free and reduced lunch.

19 Results in this section are model-based effects from three-level hierarchical linear models that account for measurement error and then portion student- and school-level variance separately. Each student characteristic, such as gender, was modeled separately without controlling for other demographic factors. We also performed more elaborate models that examined each group difference controlling for the other demographic factors. When relevant, we discuss whether the group differences we see at the bivariate level disappear when other student or school characteristics are controlled. See Appendix B for more details.

20 Economic status is based on students' place of residence—the characteristics of the census block group where students live. The measure is derived from census data on the percentage of families under the poverty line and the percentage of unemployed males in the students' census block group. This measure is much better at discerning economic differences between students than the often-used criterion of whether the student qualifies for free/reduced lunch, since 85 percent of CPS students qualify as low income. We grouped students into quartiles based on this measure to distinguish those who live in high poverty neighborhoods from those who live in low poverty areas.

21 This was based on students' performance on the Iowa Tests of Basic Skills (ITBS) for elementary school students, or on the Tests of Achievement and Proficiency (TAP) for high school students.

22 The relationships between the student demographic variables and the technology variables were similar within schools and across the system.

23 Among elementary students, difference in non-response rates between the highest achieving quartiles and lowest achieving quartile was 10 percent. In high schools, this was close to 20 percent.

24 One special education teacher explained, "It's been a tremendous tool for kids that are learning disabled, for example, who have trouble getting things in writing....They're still going to have errors in it...but they can fix them, and they produce something that is on the same level as the rest of the class.... Technology has taken that stigma away....It's made a big, big difference."

25 Sutton (1991); Butler (2000).

26 Small differences between types of schools appear larger in the displays than differences between types of students because there is three times more variation in computer use and availability among students than among schools.

27 Because there are only four predominantly Latino high schools in our sample, this difference did not emerge as statistically significant in the multilevel analysis. However, three of the four schools had substantially lower than average reports of computer availability (i.e., one standard deviation or more below average).

28 Although these data suggest that teacher use and assignment are not correlated, in fact they are. We find that personal use and student assignment are positively correlated (r=0.39 among elementary teachers; r=0.46 among high school teachers).

29 Students in low achieving schools show a different pattern than teachers in terms of use; students at these schools report the lowest levels of access to technology, but the highest levels of use. This incongruence between teacher and student reports is initially surprising because, in general, students report using technology more in schools where teachers report assigning it more. There are many potential explanations for these inconsistencies, however. The Consortium's survey asked students questions about how frequently they use a computer "at school" to perform various tasks. Higher achieving students could be working on assignments more at home. Alternatively, high achieving students may need less time to complete assignments involving technology than low achieving students. Our data cannot determine the reason for these differences.

30 Wenzel et al. (2001).

31 Computer availability explains about 45 percent of the school variance in student computer use beyond demographic characteristics and student-level characteristics alone.

32 This may be due to students with greater home access having less of a need to use technology at school for assignments.

33 Teachers' use of technology for their own professional work explains over 17 percent of the person-level variance in assignment of technology at the elementary level and over 40 percent of the school-level variation (22 percentand 61 percent, respectively, at the high school level).

34 Our measure of home computer use explains 13 percent of the person-level variance in the measure of professional use of computers and almost 15 percent of the school-level variance in professional computer use at the elementary level (9 percent and 19 percent, respectively, at the high school level).

35 Professional development in technology explains only 1 percent of the person-level variance in assignment of technology, and 3 percent (high schools) to 5 percent (elementary schools) of the person-level variance in professional use of technology. It does explain, however, substantial proportions of the school level variance in assignment of technology, (8 percent elementary, 13 percent high school) and professional use (18 percent elementary, 33 percent in high schools).

36 Even after entering all other technology variables, belief about the utility of technology remains a significant predictor of both teacher professional use and teacherassignment of technology. Because belief is correlated with other technology predictors, however, it adds only slightly to the variance explained in the model beyond other technology and demographic variables.

37 Most of the variance in both teachers' professional use and assignment of technology exists at the individual level (i.e., there are more differences within schools than between them). Of the variance that exists at the school level, much can be explained by teachers' individual characteristics and professional development experiences(i.e., teachers with certain characteristics tend to be located at certain schools). For example, at the elementary level, 50 percent of the school-level variance in assignment of technology is explained by teachers' demographic characteristics, use for their own professional work, home use, and the quality of their professional development (70 percent at the high school level). See Appendix C for further details.

38 The effect of professional community on professional development persists after controlling for all other technology and demographic variables.

39 Controlling for teacher access to computers, student access is a significant predictor of teachers' assignment of technology.

40 At the elementary level, computer availability explains 25 percent more school-level variation in teachers' professional use of technology than demographic and individual-level characteristics alone (13 percent at the high school level), and 18 percent more school-level variation in teachers' assignment of technology (not calculable at the high school level).

41 After controlling for demographic characteristics and the other technology variables in the model (including principal support for technology) the relationship between human resource support and technology availability for teachers is still very strong.

42 Figure 15 shows the bivariate relationship between human resource support and teachers' assignment of technology. Even after controlling for technology availability, however, human resource support is significantly related to teacher assignment of technology, explaining an additional 3 percent of the school-level variance in elementary schools.

43 Principal support for technology is a strong predictor of technology availability, teacher professional development in technology, and professional community around technology. It is through these mechanisms that principals have an impact on teachers' and students' use of technology. Once we control for availability, professional development, and professional community, principal support for technology is no longer a significant predictor of use.

44 The within-school variance in teachers' professional use of technology was 9.2 times greater than the between-school variance. The within-school variance in teachers' assignment of technology was 8.4 times greater than the between-school variance. Likewise, the within-school variance in students' use of technology at school was 2.6 times greater than the between-school variance, and the within-school variance in students' use of technology across the curriculum was 4.4 times greater than the between-school variance.

45 Means, Penuel, and Padilla (2001), 228.

46 Wenzel et al. (2001).

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# Consortium on Chicago School Research



## Mission

The Consortium on Chicago School Research is an independent federation of Chicago area organizations that conducts research on ways to improve Chicago's public schools and assess the progress of school improvement and reform. Formed in 1990, it is a multipartisan organization that includes faculty from area universities, leadership from the Chicago Public Schools, the Chicago Teachers Union, education advocacy groups, the Illinois State Board of Education, and the North Central Regional Educational Laboratory, as well as other key civic and professional leaders.

The Consortium does not argue a particular policy position. Rather, it believes that good policy is most likely to result from a genuine competition of ideas informed by the best evidence that can be obtained.

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