

Where We Are

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Getting information off the Internet is like taking a drink from a fire hydrant.

—Mitchell Kapor Founder, Lotus Development Corporation
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TECHNOLOGY CONTINUES TO ADVANCE AT SUCH a rapid pace that one barely has time to get accustomed to one device or program before another one comes along to replace it. Smartphones are going through upgrades every few months, and new sites appear on the Internet daily, barely leaving us time to catch our breath. Therefore, this is a good time to pause and look at how teachers and students view the growing presence and increased role of technology in our schools.

VIEWS AND STATUS OF TECHNOLOGY IN SCHOOLS

Surveys conducted by several government and private institutions give us an idea of how much money is being spent on educational technology and how that technology is being used in schools. In 2022, schools spent a record \$43.5 billion on educational technology, according to a survey by the Learning Counsel Research Institute (Learning Counsel, 2022). This amount is an increase of 18.5 percent over the 2021 amount of \$36.8 billion. These expenditures on technology include hardware, major systems, networks, and digital curriculum.

A survey of educational technology used in public schools was conducted in 2021 by the National Center for Education Statistics (NCES) and included 800 schools and about 83,700 students (Gray & Lewis, 2021). Forty-five percent of schools reported having a computer for every student, while an additional 37 percent reported having a computer for every student in some grades or classrooms. As for instructional use, just over 70 percent of schools said that 71 percent of their teachers used technology for activities normally done in the classroom to a moderate or large extent.

Table 1.1 shows the percentage of school responses when asked whether technology was affecting student learning. Thirty-three percent of schools strongly agreed that the technology helped students to be more independent and self-directed. Thirty-five percent answered that technology helped students to learn at their own pace, while 30 percent said it encouraged students to learn collaboratively with their peers. Forty-one percent said it helped students learn more actively, and 27 percent said it helped students think critically. Schools were asked about challenges their teachers face in using technology for teaching purposes. Twenty-two percent said that outdated computers or software was a moderate challenge. Another 12 percent said that was a large challenge. Twenty-six percent of schools said that lack of support on how to use technology for teaching was a moderate challenge and another 8 percent said it was a large challenge.

In 2019, the Gallup Organization conducted an extensive survey of more than 5,500 teachers, principals, and district

TABLE 1.1 • School Responses to Whether Technology Affects Student Learning

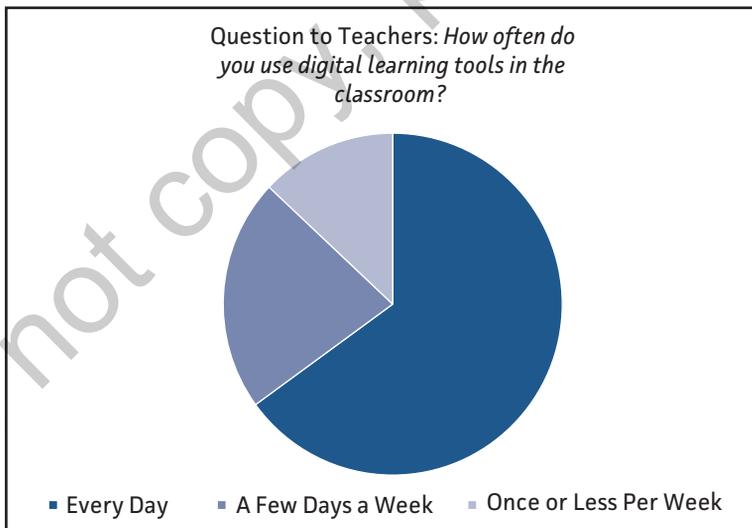
TECHNOLOGY IN OUR SCHOOLS HELPS STUDENTS. . . .	PERCENTAGE
Learn more actively	41
Learn at their own pace	35
Be more independent and self-directed	33
Learn collaboratively with their peers	30
Think critically	27

Source: Compiled and adapted from Gray & Lewis (2021)

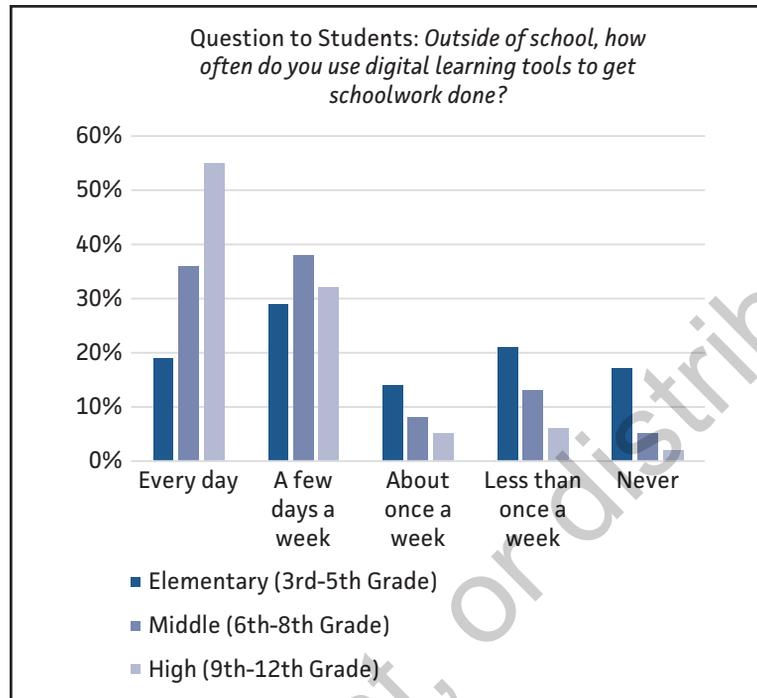
administrators as well as nearly 2,700 students on the use of technology in schools (Gallup, Inc., 2019). The survey was taken before the beginning of the COVID-19 pandemic of 2020. At that time, 65 percent of teachers said they used digital learning tools in the classroom every day. A smaller number, 22 percent, used them several days a week, and only 13 percent used them once or less per week. Meanwhile, 42 percent of students said they would like to use digital learning tools more often in their lessons. About seventy percent reported using digital learning tools for schoolwork outside of school at least several days a week. Figure 1.1 shows the results of this survey.

The Gallup survey also revealed that most teachers (85 percent), principals (96 percent) and administrators (96 percent) supported the increased use of digital learning tools in their schools. Selecting the tools, however, needs to be done more carefully as 65 percent of administrators said their district stopped using a digital learning tool that was in use, mainly because it did not improve student learning.

FIGURE 1.1 • How Often Digital Learning Tools Are Used



(Continued)



Source: Data Retrieved from: <chrome-extension://efaidnbmninnibpcapjcgclcfndmkaj/http://www.newschools.org/wp-content/uploads/2019/09/Gallup-Ed-Tech-Use-in-Schools-2.pdf>. Graph created by Natalie Delpino.

How Technology Is Changing Student Learning

No one questions that technology is changing schools and the ways students are learning. The question is how those changes are affecting curriculum, instruction, assessment, and student achievement. It is still too early to make definite statements about the long-term impact of these changes, as well as the effects of the interruptions in schooling caused by the COVID-19 pandemic of 2020–2022. Here are some changes worth noting.

Students Pick Their Instructional Model

Some schools are using technology to allow students to pick how they want to learn by choosing from among different instructional models. These models include traditional teacher-led direct instruction, as well as project-based, virtual, self-paced, and peer-led formats, among others. This student-centered approach is likely to increase as more schools

recognize the need to adopt initiatives that focus on student-centered learning.

Online Whiteboards Have Replaced Blackboards

Middle-aged adults who visit a classroom today will see a very different environment. The blackboard is gone, replaced by online whiteboards that allow students to increase their creativity and productivity through collaborative activities. Online whiteboards are synchronized with the students' individual computers, making it easy for them to copy notes or view multimedia. LCD projectors have replaced overhead projectors. Many classrooms are using pencils and paper a lot less now that laptops are widely available. Desks are on rollers and organized in circles or in groups, rather than in rows. Instead of raising their hands to answer teachers' questions, students can use their smartphone, tablet, or laptop to record and display their answers on the online whiteboard. Feedback like this in real time increases *motivation* because students are continually aware of their progress.

Students Trade Paper Texts for Electronic Texts

Do you remember when pediatricians were worried that the heavy backpacks young children carried could affect their spinal development and posture? As schools replace more textbooks with electronic books, those fears can melt away. Learning on a tablet is more personal and accessible than being tied to a desk. Furthermore, digital texts quiz students after every chapter, highlight the material they need to review, and provide teachers with data to help them make instructional decisions. At this time, the few studies on whether this approach actually improves student achievement are inconclusive.

Students Learn About Computers and Gaming

Computer classes have come a long way. Now, students learn about computer coding, three dimensional printing, and video game development. Every December, millions of students from around the world take part in an "Hour of Code," an international movement to get even more young people involved in computer coding. Additional events can be

planned locally throughout the year. Gaming has caused a shift in the way students learn by replacing dull periods of concentration with emotional engagement. As we will see in Chapter 4, whenever new learning involves emotions, there is a higher probability the student will remember the learning. With gaming, learning becomes less of a theoretical endeavor and more of an emotional and engaging activity.

Students Are Allowed to Use Cell Phones

Most schools banned cell phones when they first came out. However, with so many cell phones in use, it was very difficult to enforce the ban. Teachers are more comfortable with students using their cell phones for research, and many schools use smartphone apps in classrooms. Under the supervision of their teacher, students can use their smartphones to create *podcasts* related to their schoolwork or to respond to teacher surveys about upcoming curriculum topics.

Students Are Interacting with Artificial Intelligence (AI) Technology. When ChatGPT erupted on the educational landscape not too long ago, it became apparent that the students' rewired brains were keenly attracted to artificial intelligence technology. AI technology poses both promises and concerns over its use. It is already in the classroom. The ongoing challenge is how do teachers and students work together to use AI productively in both teaching and learning, and what skills should students learn to interact with AI as smart and responsible consumers? Ways for teachers to help students develop AI literacy are discussed in Chapter 7.

How Technology Is Changing Teachers

Experienced teachers in recent years have had to make major changes in their instructional approaches to accommodate the various technologies that have flooded into the classroom. These accommodations have changed the way teachers interact with their students even as they attempt to overcome some major obstacles when using technology. Teachers who were resisting using technology in their instruction were forced to get more involved when the COVID-19 pandemic quickly closed schools and replaced in-person classroom instruction with a distance learning model largely controlled

by technology. In an instant, the whole dynamics of the teaching-learning experience was drastically altered for nearly two years. This shift forced the rapid adoption of even more technology to keep students and teachers connected during the pandemic.

Teachers View Their Students and Roles Differently

Technology has changed the way teachers view their students and their own role in the classroom. Young brains have the advantage of adapting to emerging digital technologies faster than adult brains. They learn how to manipulate the devices, create shortcuts, and even develop their own language abbreviations to communicate more efficiently with their peers. Teachers report that technology is having a significant impact on how their students interact with each other and how they approach their learning tasks.

A survey conducted by Common Sense Media in 2019 included a nationally representative sample of more than 1,200 K-12 teachers (Vega & Robb, 2019). The survey asked the teachers about their usage of digital tools and their perceptions of the tools' effectiveness for student learning. About 60 percent of the teachers said video-streaming sites, such as SchoolTube, YouTube, and Netflix, were the most common digital tools they used. Productivity and presentation tools, such as Microsoft Office, was the second most common type of digital tool, used by about 50 percent of teachers. Among the least used digital tools were tools for well-being and health (25 percent), and social media (13 percent).

One intriguing finding in the Common Sense survey was the apparent gap between the digital products teachers use and what they say is effective. For example, mathematics teachers and teachers of English Language learners rated certain digital tools as the most effective for developing content knowledge and skills, but often used other digital tools that they had rated as less effective with greater frequency.

It is intriguing to note that although a large majority of teachers recognizes the many positive aspects of learning with technologies, nearly two-thirds of the teachers surveyed felt that these technologies distract students more than help them

academically. High school teachers expressed more concern than middle school teachers did over the digital distractions. These concerns, of course, mean that teachers need to find ways to use the technologies to enhance their students' progress toward the learning objective while minimizing their potential for distraction. We will investigate suggestions for how to accomplish this in the following chapters.

Teachers Face Obstacles When Using Technology

Teachers report that they still face obstacles over the use of technology in their classes. Professional development to help teachers with using technology effectively continues to be a major issue. For example, in the NCES survey, 47 percent of schools said that their teachers were given training that focused on how to use computer software to a moderate or large extent. Fifty-three percent said that their teachers were trained on how to use technology for teaching and learning during classes for specific subjects to a moderate or large extent. Schools were asked what staff worked with teachers to bring technology into classes for teaching and learning. Fifty-seven percent reported that content specialists from the district worked with teachers for this purpose. More than 60 percent of schools reported using experts in educational technology or other classroom teachers with training in technology, and 76 percent reported using staff like library media experts. Despite these training initiatives, only 18 percent of schools agreed that teachers are sufficiently trained in how to use technology or have enough training to use technology for teaching. A mere 34 percent said that technical support for technology in the school is good enough.

In the Common Sense survey, only 40 percent of teachers considered the professional development they received to support their use of educational technology to be "very" or "extremely" effective. Furthermore, about 34 percent of teachers said that they had not, or practically never, used a digital technology product that was provided to them by their district. The three main reasons they listed for not using these products were that they were not relevant to their students' learning needs, not engaging for students' learning, or not effective for developing the students' knowledge and/or skills.

Another obstacle facing teachers who are using more technology in their lessons is the degree of home access that their

students have to a computer and the internet. This is a bigger issue in Title 1 schools where fewer students have a computer and home access to the internet than in non-Title 1 schools. This obstacle is likely to be eased as more districts allow students to take school-owned laptops home.

Does Technology Improve Student Achievement?

Teachers make a huge difference in the effectiveness of technology.

Technology has spread so rapidly in classrooms that conducting research comparing the effectiveness of instruction assisted by digital technology to instruction without this assistance is difficult and of questionable value. The technology is here to stay and it will expand into more classrooms and homes. Before the pandemic, John Hattie's (2018) meta-analysis of more than 250 factors related to student achievement found an effect size of 0.55 for technology-assisted instruction in academic subjects. This is a moderate effect size that translates to a percentile gain of 21. The disruptions caused by the pandemic appear to have paused any on-going research into the effectiveness of specific technology-based interventions.

Perhaps the more meaningful question to ask is, "Does the way teachers use technology in instruction improve student achievement?" Technology is a tool, and how and why teachers use this tool to help students learn usually determines how well those students succeed. Studies that look at how technology affects student achievement have largely focused on computer-assisted instruction (CAI) because that practice has been in use for around two decades. Although no single study can definitively assert that CAI *alone* improves student outcomes, collections of studies provide ample evidence that technology can enhance student motivation, engagement, knowledge, and skills when teachers thoughtfully integrate it into teaching and learning. In other words, teachers make a huge difference in the effectiveness of classroom technology.

One area where technology has had a significant impact involves student engagement. The lure and spread of digital devices in schools has captured the attention and interest of today's students, resulting in their increased engagement in

learning and other school activities. Engagement matters. A Gallup study that included 128 schools and more than 110,000 students found that student engagement and hope were significantly and positively related to student academic achievement (Rechmeyer, 2019). This growth occurred in mathematics, reading, and all subjects combined, along with postsecondary readiness in mathematics and writing. The study also found that schools in the top quartile of student engagement had significantly more students exceeding and meeting proficiency requirements than schools in the bottom quartile of engagement.

WHAT IS STUDENT ENGAGEMENT?

Simply put, genuine student engagement is the amount of attention, interest, curiosity, and positive emotional connections that students have when they are learning, whether in the classroom or on their own. Furthermore, it describes their willingness and desire to participate in their work and take genuine pleasure in accomplishing their learning goals. Their degree of engagement often determines whether they will persist when encountering obstacles and challenges and be motivated to pursue the new learning to higher levels for deeper understanding. And engagement works! An extensive meta-analysis showed a strong positive correlation between the degree of students' engagement with their learning and their academic achievement (Lei, Cui, & Zhou, 2018).

Levels of Student Engagement

Engagement is a vital part of the school experience and runs on a spectrum. Schlechty (2002, 2011) describes five levels of student engagement, and Heick (2018) describes the main characteristics of each level:

1. **Authentic engagement.** Students are fully immersed in their schoolwork, see immediate value in what they are learning, and are motivated to pursue their new learning beyond the classroom. Characteristics: Persistence, sustained inquiry, self-direction, playfulness with content, and unprompted transfer of understanding.

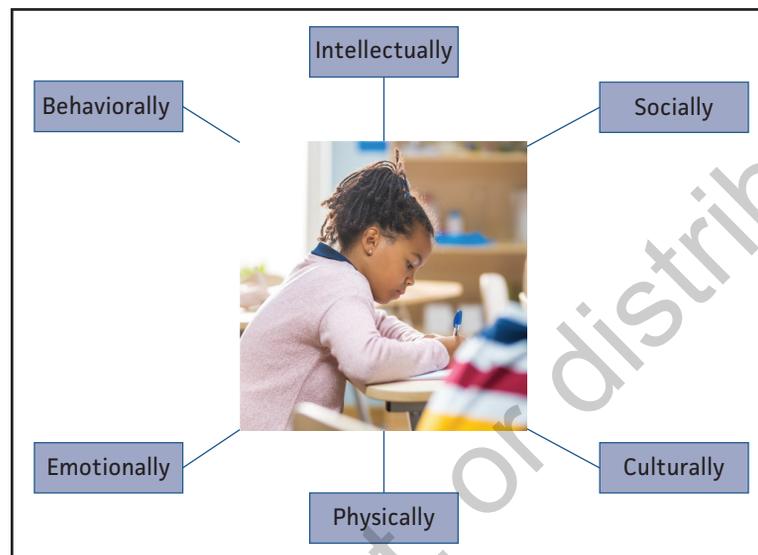
2. **Ritual compliance.** Their schoolwork makes sense but has little or no meaning. However, they stay engaged to benefit from extrinsic outcomes that they value, such as getting good grades to get into college. Characteristics: Clear effort, some creativity, focus on directions and completing tasks to meet external standards for motivation.
3. **Passive compliance.** There is little or no meaning in their schoolwork, but they persist to avoid negative consequences, such as staying after school or during recess to complete their work. Characteristics: Minimal effort made only to mitigate consequences or other negative punishers; no creativity, genius, curiosity, or transfer.
4. **Retreatism.** Although the students are not engaged in their schoolwork nor do they intend to, they do not interfere with other students' learning. Characteristics: Little to no effort, productivity, or progress; no demonstrated inquiry, affection, or interest in the content, collaborations, or task.
5. **Rebellion.** Students refuse to do their schoolwork, are disorderly, and turn to alternative activities in the classroom. Characteristics: Zero demonstration of learning; outright disruption and defiance.

When students disengage from their school, they become behavior problems, disaffected, and dispassionate and may eventually drop out of school completely. That is why it is so important for educators to purposefully plan ways to encourage authentic student engagement in all aspects of school life.

Types of Authentic Student Engagement

Students can engage with their learning, peers, teachers, and school environment in different ways that include both cognitive and noncognitive interactions. Research in recent years has pointed out the importance of non-cognitive factors in the learning process, such as motivation, curiosity, responsibility, attitude, and social skills. We can look at six ways in which students' engagement presents itself in schools (see Figure 1.2): intellectually, emotionally, behaviorally, physically, socially, and culturally (Student Engagement, 2016).

FIGURE 1.2 ♦ The diagram shows the different ways that students can authentically engage with their school experiences.



Source: iStock.com/gorodenkoff

Teachers generally focus mainly on their students' intellectual engagement and create lessons and assignments that stimulate their students' curiosity and interests. Today, the attractions and distractions of digital devices and other technologies complicate the task of intellectually engaging students. Because of these media, teachers are not the only ones attempting to get their students' attention. Promoting engagement can take many forms. For example, presenting a problem to solve that involves higher-order thinking is one of many ways to engage students because the thinking skills they need to employ, such as analysis, evaluation, and creativity, are much more interesting than just memorizing facts. Additional suggestions will appear throughout this book.

Emotional Engagement

Emotional engagement is another way that students interact with their learning and with their teachers and peers. One aspect of emotional engagement is the connection that students make between their emotions and the new learning. Whenever students get emotionally involved with what they are learning, they are likely to be more engaged and much

more apt to remember the new learning (see Chapter 4). Another aspect of emotional engagement is how students feel about the environment in which the learning is taking place. Do they feel welcomed and respected? Does their teacher sincerely care about their success and about them as individuals with passions and aspirations? Is there a trusted adult in the school that they can go to regularly for advice, monitoring, and counseling? Does the school promote positive relationships between students and teachers? As we will find out in the ensuing chapters, emotions drive attention, and attention drives learning. Consequently, students who feel emotionally disengaged from their school are not inclined to become intellectually engaged.

Whenever students get emotionally involved in their learning, they are more likely to remember it.

Behavioral Engagement

Students engage behaviorally when they accept and carry out a pattern that is conducive to learning. That behavior can change when they become bored with classroom routines, cues, and seating assignments that never vary. Teachers can reduce the monotony of routines and potential disengagement by using novelty and physical movement to break up these patterns (see Chapter 3).

Physical Engagement

Much research has emerged in recent years about the importance of physical activity as it relates to learning (e.g., Ratey, 2008). Even simple movements, such as asking students to get up and write their answers on the whiteboard instead of giving them orally from their seats, are enough to stimulate brain regions that process memory. Research studies show that quick exercises before an assessment can bring additional oxygen and glucose to the brain and improve memory recall and cognitive performance (Slutsky-Ganesh, Etnier, & Labban, 2020).

Schools serving low-income adolescents should consider implementing brief sessions of aerobic exercise during the school day.

Tine (2014) found that after asking low-income and high-income adolescents to run in place for twelve minutes, their selective visual attention (SVA) and reading comprehension significantly improved. Improvement in SVA among the low-income adolescents was particularly large, substantial enough to eliminate a preexisting income gap in SVA. The effect lasted for about forty-five min. Furthermore, the mean reading comprehension score of low-income adolescents who engaged in the twelve minutes of aerobic exercise was higher than the mean reading comprehension score of low-income adolescents in the control group. However, there was no difference between the mean reading comprehension scores of the high-income adolescents who did and did not engage in the twelve minutes of aerobic exercise. One possible explanation for this difference is that low-income students may be under greater stress than high-income students and that the exercise lowered their stress level so that they could perform better on cognitive tasks. Based on these results, schools serving low-income adolescents should consider implementing brief sessions of aerobic exercise during the school day.

Social Engagement

Teachers pay a lot of attention to their students' intellectual growth but often do not remember that they are developing socially as well. As more students spend more time on their digital devices to communicate with each other, the classroom may be one of the few places left where students can work collaboratively face to face. Projects, academic contests, friendly competitions, and in-class debates are just some of the strategies that teachers can use to have students interact with each other and share their learning experiences. The arts offer a valuable means of getting students to join forces and work toward producing musical concerts, dance programs, and plays. Research studies show that participation in the arts improves not only students' social skills but their academic achievement as well, especially for at-risk students (Catterall, 2012; Moss, Benus, & Tucker, 2018). Extracurricular activities and civic volunteer programs are additional ways that students can get socially involved with peers and members of their community. In Chapter 6, we will examine in detail the impact that digital devices are having on students' social development.

Cultural Engagement

Schools are becoming more culturally diverse every year. Therefore, it is important for school administrators, staff, and teachers to make students from all cultural backgrounds feel safe, valued, welcomed, and accepted. Teachers can consider revising their lessons to include references to the arts, history, literature, and cultural differences of the students in their classes and other cultures. Students, themselves, may wish to share information about their nationality, customs, and traditions. School events could include stories, songs, and dances that highlight the diverse nature of the local community. The objective of these endeavors is to encourage positive feelings toward all cultures in the school so that all students can comfortably engage in their work.

By recognizing the different ways that students engage with their school experience, school administrators, teachers, and staff can constantly monitor their programs and instruction to increase the amount of engagement time so students can be successful in their learning.

WHAT SHOULD TEACHERS BE ABLE TO DO WITH TECHNOLOGY?

I have asked this question of nearly a dozen school technology assistants. Essentially, I wanted to know what they considered the bare minimum competencies that teachers should have to use technology tools successfully to advance teaching and learning. While their lists of skills varied, some common ones stood out. Here they are:

- Scan a document and be able to save it as a file, such as a PDF.
- Upload photos from a digital device and know how to use them with different programs.
- Create a high-quality presentation, using a program such as Prezi, Keynote, or PowerPoint.
- Use word-processing, spreadsheet, and database programs successfully.

- Set up and conduct videoconferencing sessions.
- Navigate the Internet and search for data efficiently and effectively.
- Know how to search for, download, use, and remove apps from technology tools.
- Manage emails efficiently.
- Create a blog and know how to manage and update it frequently.
- Know how to operate an interactive whiteboard and integrate it into lessons.
- Create, copy, move, and delete computer files and folders.
- Upload videos to appropriate websites, such as YouTube.
- Know educational copyright and fair use guidelines.
- Understand how to connect with and manage social media.
- Be willing to learn new technology.
- Explain netiquette and computer ethics to students.

This list may seem daunting, but many teachers have already developed competency in these tasks just through their own personal use of technology. Furthermore, an increasing number of school districts have implemented long-range professional development programs to help teachers become better acquainted with current and emerging technology tools and how to use them.

WHAT'S COMING

Researchers have been looking into ways that modern technology may be affecting brain growth and development. In the next chapter, we look at some of their surprising findings, a few of which seem counterintuitive but have real implications for parents and teachers.