

Converging Trends in Educational and Assistive Technology

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Setting the Stage

The work of the National Center for Technology Innovation supports the notion that all students can benefit from accessible and assistive technology (AT) and the ways these tools can promote learning. This chapter provides an overview of the trends in technology for education and the diverse learning needs of students in classrooms throughout the nation. This convergence of trends illuminates the essential role of technology in education, especially for students who struggle or who are disengaged from academic success.

This chapter offers an introductory view of technology in education to set the stage for the chapters that follow. Drawing from national survey data, we find that while technology is found in every school and nearly every teenager's pocket, it is not being leveraged as a learning tool as often as one might hope.

We begin with an examination of trends in technology development and utilization in educational and consumer environments, and those related to policy and philanthropic investments. Building on the framework provided by the 2010 National Education Technology Plan (NETP), we explore how technology can be integrated in schools to support teaching and learning, assessment, productivity, and infrastructure. The next section looks at the diverse needs of our student population and innovative ways that technologies can be leveraged to personalize the learning experience. The chapter concludes with a call for personalization and connected teaching to ensure that all students reach their academic and social potential.

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A Short Look Back

Currently, the U.S. educational landscape reflects the infusion of technology into nearly every aspect of school life. Major changes are evident over the past 5 years in how technology is viewed and deployed in the classroom in terms of infrastructure, equipment, online learning, teacher training, and policies.

Awareness of how technology could accommodate students with special needs has gained traction in the past 5 years as assistive technologies increasingly look and function like mainstream educational or consumer technologies. More devices and online applications were being built with accessibility and customizable features making them usable by individuals with disabilities (Gray, Silver-Pacuilla, Overton, & Brann, 2010). Principles of universal design for learning (UDL) were embraced by more educators as they aimed to differentiate instruction and ensure the academic success of all students, particularly those underperforming on high-profile state tests.

Throughout the USA, education has become increasingly entwined with the digital consumer landscape. We are no longer asking *whether* digital materials and tools should be integrated into teaching and learning, but *how*, *how well*, and *under what conditions* do they meet students' needs.

The Students' World

Meanwhile, the students' world has experienced dramatic change as well, with technology permeating nearly every aspect of daily life, often in ways that is unique to tweens and teens. The always-wired generation has left teachers and parents scrambling to imagine ways to engage students and enhance learning in the classroom. A window into the world of young people reveals:

- *Gaming* saturated the youth culture with 97% of students reporting playing regularly (Lemke, Coughlin, & Reifsneider, 2009; Lenhart, Arafeh, Smith, & Macgill, 2008), and games of all sorts being tried in instruction to engage students and to teach them such vital skills as teamwork, decision-making, and digital literacy (Chandler, 2009; Van Horn, 2007).
- *Social media* sites as a means for socializing and collaboration (Lenhart, Madden, Rankin-Macgill, & Smith, 2007) became so integral in the lives of tweens and teens that 96% of students with Internet access reported engaging in social networking and spending as much or more time online than watching television (National School Boards, 2007). More than 67% of teens with their own social network page say they update their page at least once a week (Nielsen, 2009).
- *Text messaging* became one of the more popular pastimes internationally, with the average number of texts sent and received by teens increasing 566% in 2 years (Nielsen, 2009). By late 2009, texting had taken over as the most popular form of communication among teenagers, surpassing email, instant messaging, social networking, and face-to-face communication (Lenhart, Ling, Campbell,

- & Purcell, 2010). One-third of teenagers who text daily report sending more than 100 texts per day, while 15% send in excess of 200 texts a day (Lenhart et al., 2010).
- *Portable media devices* have become ubiquitous. Three-quarters of teens 12–17 years old now own a cell phone, a sharp increase from 2004 where 45% of the teens in the same age group owned cell phones (Lenhart et al., 2010). In addition, children began to have access to these devices at younger ages with 93% of children aged 6–9 years old living in homes with a cell phone, half with their own portable video game player, and a third with their own cell phone (Shuler, 2009).
 - *Cell phones* and portable media devices have helped bridge the digital divide, providing greater access to online content to many individuals without a home computer. In households making more than \$30,000 per year, 92% had access to a computer in the home, compared to 70% of households making less than \$30,000 per year. Among low-income teens, 41% use their cell phones to go online (Lenhart et al., 2010).

The youth of today are clearly wired and tech-savvy. The Pew Research Center (2010) released a report on “millennials,” individuals who were 18–29 in 2010. In response to the question, *What makes your generation unique?*, 24% identified technology as the most important factor. This statement, in conjunction with the other factors, led the researchers to label the millennials as “confident, connected, and open to change.” The Joan Gantz Cooney Center studied younger children and found their use of media and media access devices nearly ever present, leading many to conclude that the potential for mobile learning is nearly limitless.

Despite the potential benefits of mobile learning technologies, many educators view cell phones as disruptive elements in the classroom; 24% of teens report that their schools ban cell phones entirely (Lenhart et al., 2010). However, of the students attending schools with cell phone bans, a substantial majority (65%) still bring their phones with them every day (Lenhart et al.). *Pockets of Potential* (Shuler, 2009) encourages educators to consider how to keep children learning and creating in and out of the school day. At the end of the decade, a growing number of parents, educators, and public policymakers increased the call for integrating technology into teaching and for learning to improve the acquisition of knowledge, enhance social skills, and strengthen students’ ability to express themselves (Ito et al., 2008; National School Boards, 2007).

Zhao and Qiu (this volume) explore the social implications behind these numbers from a global perspective and what these tools mean in the lives of students with disabilities. As we demonstrate later in the chapter, students and teachers both are using technology in their personal lives *more often* and *in more ways* than at school.

Major Policy Initiatives

With the continued proliferation of these technology tools and their early adoption by young people, we are challenged to unleash the power of technology and digital media for teaching and learning. The authors in this book make clear that no

government agency, organization, or program can meet these challenges alone. Rather, it will require a coordinated effort by educators, researchers, business leaders, technology innovators, policymakers, and parent groups. The key to change will be broad public engagement at all levels.

Since 2009, there has been a significant shift in public policies and standards that have pushed assistive and accessible technologies for individuals with disabilities to the forefront of the national agenda. The American Recovery and Reinvestment Act (ARRA) of 2009 initially provided more than \$100 billion to education-related efforts that included funds to address the needs of students with disabilities within the stated priorities:

- Make progress toward the establishment of research-based rigorous standards and assessments, particularly for students with disabilities and English language learners
- Provide support for the lowest performing schools to ensure that students have access to a quality education
- Improve the quality of teacher effectiveness, including the development of teacher performance assessment tools
- Establish reliable data systems to track student progress and foster continuous improvement

As a part of the ARRA funds, the U.S. Department of Education established two new competitive funding streams with the goal of fostering innovation: Race to the Top (RttT) with a budget of \$4 billion and the Investing in Innovation Fund (i3) with a budget of \$650 million. RttT was established as a competitive grant program to encourage and reward states that are implementing significant reforms in the four priority areas. To increase their odds for winning a grant, many states passed significant educational reform laws that mandated the development of more charter schools and tightened teacher accountability and tenure requirements. These are considered important by the Obama Administration but remain controversial with many teacher unions throughout the nation.

The i3 initiative was established to provide competitive grants to applicants with a record of improving student achievement in order to expand the implementation of, and investment in, innovative practices that are demonstrated to have an impact on (1) improving student achievement or student growth for high-need students and (2) promoting school readiness, closing achievement gaps, decreasing dropout rates, increasing high-school graduation rates, and improving teacher and school leader effectiveness. A total of 1,669 applications were received for the first round of funding seeking \$50 million “scale-up” grants, \$30 million “validation” grants, or \$5 million “development” grants.

The tension between the call for evidence-based practices and the potential to engage students through the use of technology, particularly those with special needs, surfaces throughout the policy initiatives of the Obama Administration. For example, a review of the NETP (March, 2010) calls for major investments to address barriers to educational technology innovation such as poor infrastructure and professional development. The 114-page document reveals an intent not only

to integrate technology throughout the curriculum (and beyond), but also to implement some major – some might say radical – changes to education itself.

Some of the assumptions questioned in the NETP are basic to public education, including age-determined grade levels, measuring achievement through “seat time,” keeping students in the same classes throughout the year, and keeping academic disciplines separate. The Plan advocates tighter integration between K-12 and higher education, and advocates for more collaboration between secondary and postsecondary institutions.

In an effort to deepen the research base for the use of technology for learning, legislation was passed to establish the National Center for Research in Advanced Information and Digital Technologies, more than 10 years in the making. The purpose of the Center is to support a comprehensive research and development program to “harness the increasing capability of advanced information and digital technologies to improve all levels of learning and education, formal and informal, in order to provide Americans with the knowledge and skills needed to compete in the global economy” (see <http://digitalpromise.org/Files/Digital-Promise-Press-Release.pdf>). Authorized in 2008 by amendments to the Higher Education Act (HEA) of 2008 (PL 110-315) and funded initially by the U.S. Department of Education, the Center intends to support the research needed to understand how best to integrate technology for formal and informal teaching and learning, and to work closely with the goals of the NETP.

Following on the heels of the NETP, the Obama Administration released its “Blueprint for Reform” for the reauthorization of the Elementary and Secondary Education Act. The law, currently known as the No Child Left Behind Act (NCLB), has been due for reauthorization since 2007. The blueprint builds upon the principles laid out with the release of the ARRA funds and offers the first step in the development of legislation for the reauthorization of NCLB. This marks the most significant undertaking in the realm of federal education policy since the law was originally mandated in 2001. The Blueprint calls for less emphasis on test scores and more on student attainment of a broad base of knowledge, increasing high-school graduation rates, and ensuring that graduates are prepared for college and the workplace. It calls for rigorous common standards and revises the accountability structure to reward schools, districts, and states that make steady progress in increasing student activity. It offers districts’ flexibility in spending funds on human capital development in exchange for long overdue reforms to teacher and principal evaluation systems. The Blueprint places particular emphasis on the inclusion of students with special needs. It calls for better teacher preparation to address the needs of students with disabilities and tests that more accurately access student abilities.

In March 2010, the Federal Communications Commission (FCC) submitted The National Broadband Plan (<http://www.broadband.gov/plan>) to Congress. This ambitious plan represents a critical step in the progress of accessible technology policy. With this effort, the FCC seeks to ensure that every American has access to an affordable national broadband network, including high-speed voice, data, and video communications, and emergency and entertainment infrastructure. The plan includes a detailed set of policy recommendations and strategies for how this goal

would be reached with the greatest degree of efficiency and affordability. Likening broadband to electricity, the executive summary calls the technology “a foundation for economic growth, job creation, global competitiveness, and a better way of life” (U.S. Federal Communications Commission, pg.1). There are four key points outlined in the plan:

1. Design policies to ensure competition
2. Ensure efficiency in asset management and allocations
3. Reform current deployment services in high-cost areas
4. Reform policies to maximize the benefits of broadband when used in public sectors like education, health care, and government

The call for a comprehensive vision for broadband reform and accessibility in public sectors is particularly acute considering the latest data from the FCC that only 42% of people with disabilities have high-speed Internet services at home and 39% of all nonadopters have disabilities (Lyle, 2010). To address the continued disparity of broadband use, the FCC is mandating the application of existing federal telecommunication requirements to Internet-based mobile and other technologies, the wider availability of video description, the need for more relevant emergency information access requirements, and the critical necessity for video programming devices and program menus to be accessible by individuals with disabilities, particularly those who experience loss of vision. While the exact parameters of the FCC’s authority to issue regulations to accomplish these objectives remains in dispute at this writing, the gravitas of the Commission to back the objectives has already begun to shape industry and community responses.

Major Philanthropic Initiatives

Concomitant with the significant increase in public policy mandates is the growing number of philanthropic initiatives that support research and innovation to expand our knowledge base of the important role of technology to engage the digital learner. The challenge for educators is to identify ways to harness our students’ passion and comfort with technology tools throughout the learning experience with the goal of heightening student engagement and participation. A growing number of foundations have provided support to identify ways to foster this type of innovation in the classroom. More specifically, the MacArthur Foundation, with an investment of \$1.7 million, established the Digital Media and Learning initiative in 2007 to provide an understanding of how digital media are changing the way young people learn, play, socialize, and participate in civic life. In 2010, the Foundation made ten awards to innovators who will deploy games, mobile phone applications, virtual worlds, and social networks to create the learning laboratories of the twenty-first century. Winners include a project to show youth-produced videos on 2,200 Los Angeles city buses; the next generation of a graphical programming language that allows young people to create their own interactive stories, games, and animations; and an online game that teaches youth the environmental impact of their personal choices.

Other foundations have made investments in technology, media, and innovation including the Knight Foundation, which funds the Knight Community Information Challenge, a 5-year, \$24 million initiative to help local foundations support creative ways to use new media and technology to engage communities. The Robert Wood Johnson Foundation (RWJF) has established the Games for Health program through a grant of \$8.25 million to build on the ongoing work to understand the potential for games to improve health and health care and to forge connections between the games and health fields. Yang and Foley (this volume) explore this initiative in their chapter, “Exergames Get Kids Moving.”

In an effort to leverage their funding resources, a dozen foundations established a collaboration to provide support for the selected winners of the U.S. Department of Education’s i3 Fund. This unique fund would provide up to \$506 billion in 2010, to match federal grants intended to foster education reform. This commitment will provide support and leverage to meet the required 20% private match serve for winning proposals. The collaboration includes: the Annie E. Casey Foundation; the Bill & Melinda Gates Foundation; the Carnegie Corporation of New York; the Charles Stewart Mott Foundation; the Ford Foundation; the John D. & Catherine T. MacArthur Foundation; the Lumina Foundation; the Robertson Foundation; the Wallace Foundation; the Walton Family Foundation; the William & Flora Hewlett Foundation; and the W.K. Kellogg Foundation. Further, this collaborative effort will establish an online portal that will allow applicants to apply for matching funds from all the foundations in one step, streamlining the task of seeking money from multiple sources. The Web site, Foundation Registry i3 (<http://foundationregistryi3.org/>), will simplify the private-funding application process and increase access and visibility for applicants.

Educational Technology in Schools

As noted earlier, the NETP presents a model of twenty-first century learning powered by technology, with goals and recommendations in five essential areas: learning, assessment, teaching, infrastructure, and productivity. The Plan also identifies a set of “grand challenge problems” that should be funded and coordinated at the national level: establishing an integrated end-to-end real-time system for managing learning outcomes and costs across our education system at all levels.

The emphasis toward personalized learning and connected teaching is described in the NETP as a teaching model in which “teams of connected educators replace solo practitioners and classrooms are fully connected to provide educators with 24/7 access to data and analytic tools as well as to resources that help them act on the insights the data provide” (NETP, p. viii). This model has the potential to create an inclusive technology-supported education that can deliver benefits to all students, their teachers, and families. However, there is a disconnect between the aims of the NETP and the realities of present-day teaching and learning, and the technology infrastructure, including hardware, software, and connectivity in schools. The data indicate that technology is becoming a growing presence in today’s schools, inching

us closer to some of the goals of the NETP, but not in a coordinated or systematic way. In this section, we contrast the NETP goals with some of the latest statistics and trends on teaching, learning, assessment, productivity, and infrastructure.

Teaching

According to a new report released by the U.S. Department of Education (Gray, Thomas, & Lewis, 2010), as of fall 2008, every single public school in the country is using computing technology in some way as part of instruction and every school has at least one instructional computer with Internet access.

Teachers report that they use technology for five key tasks including: teaching and instruction, preparing for instruction, data-driven decision-making, and their own learning, collaboration, and professional development. As for one-to-many instruction, the survey measured the availability of different teaching technologies for the classroom, finding that interactive whiteboards saw significant penetration, with 73% of schools reporting deployments. Videoconferencing systems were installed in 22% of schools, and video cameras were in 93% of schools. The study does not report teachers' frequency of use of these technologies, nor does it discuss the how much time teachers spend in training to use technology.

The presence of technology as a teaching tool in the hands of educators is only one side of the issue when it comes to technology integration. Another important role that technology tools play in schools is to promote productive inquiry and constructive project-based work, resulting in increased student engagement. Many researchers in the field of educational technology and the learning sciences are investigating the development, implementation, and outcomes of students' use of software, Web-based educational services, and online learning programs that are being offered nationwide. These learning opportunities take many forms, ranging from informal to formal settings, offered in school for credit as well as after-school programs. They use a variety of models that include various degrees of online learning combined with face-to-face interactions. Such opportunities are now even expanding in some states to include entirely online models of distance learning offered to students at all grade levels to work and learn remotely. The availability of such opportunities for U.S. students, however, is far from being either uniform or diffuse.

As for the technology infrastructure in schools, desktop computers are the most prevalent (76%); and 58% of schools had laptops on carts as of fall 2008 (Gray, Thomas, et al., 2010). While 78% of public schools reported having some form of wireless network on campus, only 39% said their wireless access was available across the entire campus. Another 30% said wireless was available in only part of the school, and 9% said their wireless connections extended only from a laptop to a cart, with the cart plugged into a wired port in a wall. While many teachers report using digital media tools (66%), digital resources (46%), and games (42%), they also report that they are lacking access to mobile computers or devices for every student, and consistent, reliable, Internet access in their classrooms.

Teacher perceptions of training and the use of educational technology indicated differences depending on the level of poverty concentration in a school (Gray, Thomas, et al., 2010). For example, a larger percentage of teachers in more affluent areas than those who work in high-poverty districts agreed that teachers are sufficiently trained in technology usage (74% versus 62%), teachers are sufficiently trained in technology implementations (67% versus 56%), technical support for educational technology is adequate (74% versus 60%), and funding for educational technology is being spent in the most appropriate ways (79% versus 69%). It appears from these data that the problems of the socioeconomic digital divide are mirrored not only in the home setting, but also within the school.

Overall, the ratio of students to instructional computers with Internet access was 3:1 (Gray, Thomas, et al., 2010). While the ratio of students to computers sounds fairly promising, and while the report indicates that a full 91% of computers in public schools were used for instruction (and almost all of them – 98% – had Internet access), the study does not distinguish whether this “instruction” reflects one-to-many use by the teacher or constructive use by the student (one-to-one). Further, the study does not address specifics as to *the extent to which* and *how* teachers and students are using technology for learning in their daily lives within the school setting.

Learning

To better understand the *ways* in which teachers and students in U.S. schools are using technology, between October and December 2009, the nonprofit organization Project Tomorrow conducted its annual survey. It elicited responses from 1,987 future teachers currently in teacher training, 38,642 in-service teachers, and 3,890 principals. They also published a complementary online survey of 299,677 K-12 students and 26,312 parents. On the whole, the results position students as a population who are primed and eager for technology-based learning opportunities, and school administrators as people who readily see the potential and promote the benefits of technology, teachers, however, come across as a population with mixed opinions and perceptions of the utility, feasibility, and benefits of integrating technology for teaching and learning.

Students are increasingly taking responsibility for their own learning, defining their own education path through alternative sources, and feeling a responsibility for creating personalized learning experiences. The survey of students (Project Tomorrow, 2010) found that:

- Close to 65% of students in grades 9–12 *communicate* with other students using technology for schoolwork; 51% of 6–8 graders and about 12% of those in grades 3–5 use technology for this purpose.
- Close to 50% of students in grades 9–12 use social media tools to *collaborate* for schoolwork; 34% of 6–8 graders use technology for this purpose.

The technology-based activities engaged by students include: playing online games or simulations; tutoring others and seeking help via social network; taking tests online; completing writing assignments; turning in papers for plagiarism checks; creating slide shows, videos, or Web pages; using online text books; and uploading assignments to the school portal. These findings support the claim that students are developing their skills as “free agent learners,” adept at choosing from available tools for multiple personal and school-based activities (Christensen, Horn, & Johnson, 2008; Project Tomorrow, 2010). Yet students consistently report that a perceived lack of sophisticated use of emerging technology tools in schools is holding back their education and contributing to their disengagement.

Overall, this survey data confirm that teaching and learning throughout the nation remain delivered through traditional, large group instruction and individual learning in the core content areas. Technology innovators and evaluators have not made clear the ways in which the array of technological tools can enrich and improve teaching and learning. Witness the recent critiques that reveal the widespread use of interactive whiteboards as simply another teacher-controlled blackboard in the classroom (McCrummen, 2010). The critical question that we must address is how to bridge the distance between the vision offered by the NETP and the realities of schools today.

Assessment

Meanwhile, as anyone involved in American education through the implementation of the No Child Left Behind Act of 2001 can attest, assessment policy matters. The accountability system put into place by the Act, including the threat of negative consequences, created a significant shift in the priorities placed on standardized tests and the performance of students and schools. Some groups were included in state tests for the first time ever. The performance of groups whose tests scores were reported as “disaggregated groups” – language minorities, students with disabilities, racial, and ethnic groups – was suddenly thrust into public debate. Advocacy groups cheered the newly available data that illustrated the “achievement gap” they had been documenting for years: even as overall scores had improved for schools, districts, and states, the performance of subgroups was often stagnant or, at best, not keeping pace with the majority of students and was, in fact, widening through the end of the last century (Artiles & Bal, 2008; García & Guerra, 2004). The inclusion of these students in school performance profiles made clear the need for more inclusive assessments and testing practices. As a result, more attention has been paid through the past decade to document the efficacy of accommodations and alternate forms of assessments.

The NETP calls for smarter assessment systems which require the innovative use of technology to create the “instrumented classroom” (U.S. Department of Education Office of Educational Technology 2010). The technology-based assessments envisioned in the NETP are systems that align with learning to offer formative and diagnostic data for instructional decisions. These systems would represent a new

generation of tests that offer adapted versions of test items, require constructive responses to real-world type test items, and would be aligned to standards and curriculum sequences in order to suggest instructional plans. This vision is far from reality in most states and districts which are only now completing a full implementation of standardized one-size-fits-all type of testing protocol with accommodations made on individual basis.

Russell (this volume), in the chapter *Personalizing Assessment* could be universally designed so that all students can demonstrate what they know, without the need for time- and resource-intensive accommodations.

Productivity

Great potential can also be found in utilizing technology to coordinate administrative processes throughout the field of education. The NETP suggests drawing on productivity technology for measuring and managing costs, using data in decision-making, employing iterative design and development, reorganizing teaching and learning, and extending learning time.

Productivity software can be especially beneficial when managing the needs of students with disabilities. Although paper-based individual education plans (IEPs) are still prevalent throughout local education agencies in the USA, developers of electronic IEP software are quick to note features offered through their systems, including Medicaid claim capabilities; a data bank of IEP goals, objectives, and benchmarks; and language translation to better engage parents who are not fluent in English (Serfass & Peterson, 2007). Furthermore, electronic IEPs that align with a district's student information system enhance access to information needed for the IEP process, such as grades, attendance records, test scores, and discipline information (THE Journal, 2008). Such features can make the IEP process and monitoring more efficient, saving teachers valuable time which can be redirected toward pressing needs of the students they serve. Furthermore, many of the features of electronic IEPs serve as safeguards to errors and the exclusion of information, thus increasing the likelihood that schools and districts stay in compliance with the law. Technology can also be used to support the IEP process by tracking a district's assistive technology inventory to inform purchasing needs for students who require such support.

Productivity tools that support data-driven decision-making have also received significant attention. Public schools reported that they used their district network or the Internet to provide standardized assessment results and data for teachers to individualize instruction (87%), to inform instructional planning at the school (85%), online student assessment (72%), and high-quality digital content (65%) (Gray, Thomas, et al., 2010). The study does not indicate the extent to which teachers use technology and the Internet to help prepare lessons or to engage in ongoing professional development opportunities.

As suggested in the NETP, productivity technology should be used to organize efforts of an entire system to help relevant stakeholders work together in the best interest of the students they serve. However, while software vendors offer information

on their respective IEP software, little objective information is available to education professionals on identifying IEP management systems that would best address their needs. More objective research and reviews of these software packages would help district personnel be more informed consumers.

Infrastructure

Expanding and enhancing schools' and districts' infrastructure for technology use is another major component of the NETP. One of the stated goals of the NETP is: "All students and educators will have access to a comprehensive infrastructure for learning when and where they need it" (p. 51). The reality of school capacity as outlined above indicates the need for help to ensure that equipment is functioning, regularly updated, and supported; teachers are trained to use what is available; and systems are interoperable. The NETP recognizes that these issues are negatively impacting the effective use of technology for teaching and learning.

Recommendations in the Plan in the Infrastructure section reflect the need to pay attention to capacity building – equipment, broadband access, software, open source content, and human expertise. The Plan also acknowledges the need to address outdated policies that are creating barriers, such as the restrictions in the eRate program on Internet safety and school network security. The eRate program has had a significant impact on making technology equipment and Internet access available to schools since it was enacted in 1998, but outdated regulations are hampering schools' efforts to adopt new models of service delivery, such as allowing students to access the school network through their own devices (*Sources: E-Rate Overview: <http://www.universalservice.org/sl/about/overview-program.aspx> cited in NETP, p. 55*).

The Plan recognizes that "effective process redesign within school systems will require close coordination among all these functions" (p. 60). The imperative for teamwork to address infrastructure issues of access, interoperability, support, and implementation has long been a theme in the training for assistive technology implementation. Nationally recognized groups such as the Quality Indicators for AT (QIAT: http://natri.uky.edu/assoc_projects/qiat/) and the National Center on Accessible Instructional Materials (AIM) Consortium (<http://aim.cast.org/>) have long maintained the importance of teams and processes that will sustain high-quality implementation of accessible and assistive technology for students.

Struggling Student Trends and Statistics

Several national indicators clearly document that there are many struggling students for whom teaching and learning as usual is not meeting their needs. This section provides the key indicators to understand the numbers for struggling students, be they those with diagnosed disabilities, chronic health concerns, general

disengagement, or others who are not succeeding in the current curriculum. Although English language learners represent a large and growing population in our schools, the role of technology to support their learning is beyond the scope of this chapter. There is a growing body of evidence that underscores the critical role that technology can play with these struggling students, but the practices and research are still emerging.

One indicator of struggling students is a continued high rate of noncompletion from high school. While the national dropout rate is decreasing, it remains at an unacceptably high rate, particularly among certain groups of students. Nearly one in four students fails to graduate from high school on time. Low-income students drop out of school at rates ten times higher than middle- and high-income peers. Hispanic students born in the USA have dropout rates that hover around 11%; that rate is closer to 35% for Hispanic students who are foreign-born (Cataldi, Laird, & KewalRamani, 2009). Nearly 44% of students receiving special education services for emotional disabilities drop out of school before completion, and 28% of special education students of all categories do not complete high school (National Longitudinal Transition Study – 2, 2005).

How is technology being used to address this issue? Results from a recent national survey of K-12 districts indicate that 75% of U.S. districts have students enrolled in online courses and that the number of K-12 students engaged in online courses in 2007–2008 was over one million (Picciano & Seaman, 2009). Credit recovery, or re-taking classes which were failed, is one of the most common applications of online courses; more than half of respondents from another national survey of administrators from 2,500 school districts reported using online learning in their schools for credit recovery, with just over a fifth (22%) reporting “wide use” of online learning for this purpose (Greaves & Hayes, 2008; Watson & Gemin, 2008). Even school systems not integrating online learning in a systematic way are finding such online learning alternatives appealing to otherwise disengaged struggling teens.

Today, special education in the nation is facing new challenges and opportunities. Federal law governing special education, the Individuals with Disabilities Educational Improvement Act (IDEA) as reauthorized in 2004 with regulations released in 2006, brought several of the current policies into the forefront of educational practice.

- Response to Intervention (RTI) quickly gained popular support as a school-wide approach to disability identification and reduction by more deliberate, diagnostic instruction, particularly for early reading and mathematics (see the National Center on RTI, <http://www.rti4success.org/>). Effective management of the data collection and analysis necessary to coordinate RTI can be supported by productivity software and data visualization displays.
- Universal Design for Learning (UDL) was codified into law as an approach that could accommodate diverse learners within the general classroom and curriculum. Its core principles of providing for multiple means of expression, reception, presentation, and assessment rely heavily on technology for teacher productivity and adaptable instructional materials.

- The National Instructional Materials Accessibility Standard (NIMAS: <http://aim.cast.org/>) was included in the 2006 IDEA regulations, requiring publishers of instructional materials to provide source files to a repository from which schools could deliver them to students with print disabilities in a variety of formats. These formats are all managed with technology, and many of the student-ready versions are digital, requiring devices or Internet access to use.
- The directive to include students in the general education classroom and be taught with the general curriculum to the greatest extent possible begins the transfers of responsibility for special education services for the majority of students to the general education teacher, in collaboration with a special educator.

These trends are shifting the way special education is planned and delivered and how students are classified and served. As the NETP points out, NIMAS represents a paradigm shift in how disabilities are recognized and accommodated:

The dramatic effect of the NIMAS legislation is not really in the technology itself, but in the change in how we think about diversity that the technology promotes. The conceptual shift is evident in that Congress calls for schools to provide alternative versions for all students who have “print disabilities.” In that remarkable wording shift, “learning disabilities” to “print disabilities,” lies a profound alteration in the response to diversity and disability. By recognizing that many learning problems are resident not just in the child but in the medium of instruction, the NIMAS legislation also recognizes that the limits of print are too costly for American education. Printed textbooks cannot adequately meet the challenge of diversity, and we will need to shift our educational practices to new technologies that – through more universal designs – are equitable and effective for all of our learners.

Indeed as educational and assistive technologies merge and general and special education “blur” (Fuchs, Fuchs, & Stecker, 2010), the distinctions are increasingly difficult to make. The most recent data representing 2006–2007 (<http://www.ideadata.org>) show that special education services were provided to 7.7% of school children or 6.1 million students. Over 57% of them spent more than 80% of their school day in the general education classroom. High-incidence disability groups (such as students with learning disabilities, communication or speech-language disorders, and other health impairments, which include chronic diseases and Attention Deficit Hyperactivity Disorder) are leading this trend toward inclusion, many of them served 100% of the time in the general classroom. A recent example of this convergence is the decision by the Chancellor of the New York City schools to dismantle special education programs and mainstream the majority of students into general education classrooms and schools.

While every student served under IDEA is eligible for the consideration of assistive technology which could support their achievement and independence, the rate at which AT is actually delivered and supported for children is inconsistent and not well-documented. A small survey ($n=628$) of AT use provided data to describe students using AT by grade level, disability category, sex, ethnicity, and placement in the school (general education class, special education class, alternative school, etc.) (Quinn, Behrmann, Mastriopieri, & Chung, 2009). Those with multiple disabilities were reported as using AT most frequently (27.7%), followed by students with learning disabilities (16.7%) and orthopedic impairments (14.6%). Students were more likely

to use AT in self-contained special education classrooms (40.4%) and resource rooms (19%) than in general education classrooms (11.5%) or at home (2.3%). Such low utilization is echoed in studies of students with visual impairments which estimate that only 40% of students are learning with technology in schools (Kapperman, Sticken, & Heinze, 2002; Kelly, 2008) or studies of students with learning disabilities that estimate 25–35% are learning with technology (Cortiella, 2009).

Meanwhile, the national survey on children, with special health care needs (CSHCN), documents those children who require above-routine health and related services for ongoing physical, emotional, behavioral, or developmental conditions. From this dataset, it is estimated that 10.2 million children have such needs (U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Bureau, 2007). Researchers estimate that 13–20% of all children (Bethell, Read, Blumberg, & Newacheck, 2008) and an estimated 16.8% of adolescents aged 12–17 have a special health care need (Mulye et al., 2009). Children with these conditions may or may not be receiving special education services, clinical therapy, or assistive technology devices or services.

Some of the fastest growing childhood special health conditions include autism, attention disorders, obesity, diabetes, and asthma. Specifically, autism and Autism Spectrum Disorders (ASD) is the fastest growing special education category. From the 1992–1993 to 2001–2002 school years, data indicate an expansion of 528% and an annual average growth of 22.7% in this category (Safran, 2008). It is estimated that ASD impacts one of every 150 U.S. children (Centers for Disease Control and Prevention, 2007). Attention Deficit Hyperactivity Disorder (ADHD) affects an estimated 8.8% of U.S. children aged 6 through 17 (CDC, 2003), and it is often diagnosed as a co-occurring condition with other health or learning conditions. Children with ADHD now constitute the majority of the special education categories of Other Health Impaired and Emotional Disturbance and substantial proportions of the Learning Disability and Mental Retardation categories. Many other children with ADHD are served under Section 504 plans and spend their day in general education classrooms (Schnoes, Reid, Wagner, & Marder, 2006, p. 494). How active gaming or exergames could benefit the health of these children is explored in Yang and Foley (this volume).

From the CSHCN dataset, the need for and provision of assistive technology devices and services to address impairments and needs are also documented. Benedict and Baumgardner (2009) estimate that 49% of children with special health care needs require AT and AT services, defined in the dataset as vision or hearing aids or care, communication or mobility devices, or other medical equipment. From the same survey, *unmet needs* for AT among CSHCN were reported at 25% of children requiring communication aids or devices, 9% of children requiring hearing aids, and 9% of those requiring mobility aids or devices. In fact, the researchers state that “in the U.S., identification as having special educational needs does not give children an advantage in term of access to AT” (p. 589).

Clearly, there is an unacceptable rate of unmet need for AT, whether for access, independence, or learning. And while educational and assistive technology continue to converge and general and special education continue to merge, the diversity

of students' needs is increasing. Accessible, assistive, and universally designed technology available in all learning environments is as important as ever, especially if we are to personalize learning.

The State of Assistive Technology

The Horizon Report (Johnson, Smith, Levine, & Haywood, 2010) highlights consumer technology development trends that will impact teaching and learning in the next 5 years: cloud computing, collaborative environments, game-based learning, mobile devices, augmented reality, and flexible displays. As we have described before, the convergence of general and special education services mirrors the convergence of consumer and assistive technologies.

In an effort to better understand what it means to be state of the art in the area of assistive technology and help practitioners identify such devices, NCTI contacted stakeholders in the educational and assistive technology fields to gather their perspectives. More than 100 professionals representing a broad range of sectors – education and training; academia; business and industry; federal, state, and local governments; and professional education or AT associations – offered their perspectives. An analysis of the data revealed five themes defining state-of-the-art AT, including

1. Convergence of tools
2. Customizability and UDL
3. Portability for independence
4. Research or evidence-based
5. Interoperability

NCTI drew on respondents' feedback to define each of these themes and identify specific examples (Gray, Silver-Pacuilla, et al., 2010) which are summarized below.

Convergence is defined as the transformation of various systems or devices into a single platform. Several respondents pointed to handheld communication devices such as smart phones to illustrate converged platforms. This is because in addition to serving as a means of communication, smart phones have the capability to run multiple applications (apps) that support and accompany students throughout the day. The use of apps is widespread, with over one billion downloaded to date (Pew Research Center, 2010). Furthermore, with 47% of the top selling apps targeting preschool or elementary aged children, clearly future educational possibilities are growing.

Customizability and UDL are associated with devices designed to be flexible enough to be configured to meet the unique needs of individuals. These characteristics in mainstream technology are especially important so that few students with disabilities are provided personal AT as described above. Customizable design features that can meet the needs of multiple users are becoming increasingly prevalent in the gaming industry. This industry has captured the teenage market, with 97% of adolescents between the ages of 12 and 17 playing video games. Games are associated with better cognitive, skill-based, and affective outcomes (Lemke et al., 2009), presenting an

ideal opportunity for educators to tap into students' recreational interests to promote learning. Organizations such as the Serious Games Initiative have made great effort to draw attention to the educational, social, and health benefits of digital games for students with and without disabilities.

Research and evidence on AT demonstrates the utility, interest, and efficacy of a product. Understanding such information helps educators understand what to expect of devices they consider incorporating into instructional practices for students with disabilities. Great opportunity exists in the field to engage in AT-related research. However, one challenge to state-of-the-art AT research is that assistive devices have not always kept up with the latest technologies as seen in consumer electronic devices that offer a wide range of options (e.g., wireless access and Bluetooth). In some cases, AT developers have been discouraged from incorporating new features because of funding and implementation environment mandates, and an effort to keep end users from being overwhelmed. Consequently, research that provides information on which features are most effective for which populations, under which conditions, and for which tasks is still in the early stages for AT. NCTI supports the call by the FCC's Broadband Plan to reverse Medicare and Medicaid rules that deny coverage of multi-tasking devices and would consider this as a major driver of innovation in AT development and research.

Portability to promote independence describes AT that offers flexibility to be used in various settings and that moves with the user. This is especially important given the requirement for schools to educate students with disabilities in the least restrictive environment. Portable technology enhances opportunities for students with disabilities to engage in educational experiences alongside their peers without disabilities. With more affordable portable technology becoming commercially available, such as specialized software that runs from a jump drive on any computer, more education environments are becoming less restrictive.

Interoperability refers to devices that can be used on multiple platforms, such as a Windows operating system (OS), Mac OS, or any Internet browser. The lack of interoperability can serve as a significant factor to AT abandonment (Bausch, Ault, Emenova, & Behrmann, 2008). Interoperability can also refer more broadly to the design of a system or a device that shares information such as a software program that sends reports to a school's integrated data management system. When students' clinical use of devices or accommodations is synchronized with achievement or assessment data systems, more data will be available to understand the difference AT can make for students.

Conclusion

As the digital generation continues to see technology as integral to their lives, schools are being pushed to better understand ways that these tools can become a part of the teaching and learning experience. A growing number of educators see

technology as a way to enhance the educational experience for all students, including those who struggle because the curriculum or materials are not accessible to meet their needs.

Yet research and public rhetoric on technology effectiveness is too often locked in a research paradigm that casts technology as an “intervention” rather than an enabling ecological factor (Zhao, Pugh, Sheldon, & Byers, 2002). The conundrum of innovation outpacing research is described as:

This lack of hard evidence leads some educators to question the efficacy of incorporating these new technology-based learning experiences, such as those involving digital media and online social networking, and the urgency of investment in what they consider unproven strategies. Conversely, proponents of technology investment reason that digital media are already a prevalent fixture in the lives of contemporary students, so waiting for research to confirm the promise of digital innovation before committing to expanded experimentation is unwise. To proponents, the question is not whether technology should be used in classrooms, but *how* it should be used (Wellings & Levine, 2009, p. 3).

A growing body of evidence indicates that technology *can* enhance teaching and learning to break through the challenges to the vision represented in the NETP. Personalization and connected teaching are keys to breakthrough learning through which educators can enable all students to:

- Reach their academic and social potential
- Engage in tailored learning content and experiences
- Make connections between in and out of school learning, identities, and networks of collaboration and engagement
- Participate and integrate into all aspects of education and society

Each chapter incorporates these concepts as core values and presents a kaleidoscopic view of the role of inclusive technology in assessment, exergaming, professional learning networks, social media, the minds of innovators, and UDL.

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