The Impact of Broadband on Education

A study commissioned by the U.S. Chamber of Commerce

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THE IMPACT OF BROADBAND ON EDUCATION

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The Advanced Communications Law & Policy Institute (ACLP) at New York Law School is a public policy program that focuses on identifying and analyzing key legal, policy, and regulatory issues facing the advanced communications sector. ACLP's mission is to promote robust and solution-focused dialogues amongst state and federal policymakers, academe, service providers, the financial community, and consumers concerning changes to the state and federal regulatory regimes governing wireline, wireless, broadband, and IP platforms.

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1. EXECUTIVE SUMMARY

Enhancing the educational opportunities available to students of all ages in the United States has long been a priority for policymakers, educators, and parents. Progress, however, has been slow. Indeed, a landmark study commissioned by the U.S. Department of Education in 1983 tersely concluded that the nation was "at risk" because "the educational foundations of our society [are] being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people."[1] Twenty-five years later, a follow-up study concluded that, despite successes in improving the quality of education and various test scores across most demographics,[2] the nation remained at risk, especially at a time when the "rising demands of our global economy, together with demographic shifts, require that we educate more students to higher levels than ever before."[3]

Many recent proposals for overhauling the nation's educational system – including President Obama's[4] – center on using technology to not only enhance the educational experience of students, but also to gather better data on student performance, streamline administrative processes, make educational services more widely available, and "foster critical thinking, problem solving, and the innovative use of knowledge."[5]

Among the many technologies that have been heralded as a transformative solution for education in the United States – e.g., radio, television, and the computer – *broadband has perhaps the greatest potential. This technology provides students, parents, administrators, and educators with a platform for enabling a wide range of innovative tools, services, applications, and hybrid approaches to teaching and learning.* This report focuses on the ability of broadband to affect fundamental change in education, the many positive impacts that this technology is currently having in a variety of educational settings, the barriers to further adoption and utilization, and recommendations for policymakers as they develop forward-looking educational policies. While broadband is not a panacea for education reform, it is positioned to serve as an essential vehicle for delivering content and tools that can be used to spur student engagement, enhance learning outcomes, facilitate collaboration and innovation among educators, and enable cost savings in the administration of education.

1.1 Education in the United States: Key Trends

Education in the United States is a lifelong pursuit that encompasses a wide range of activities, from pre-Kindergarten programs to continuing education classes for professionals. Recent studies have found that more than half (53 percent) of children aged three to four are enrolled in some sort of educational program,[6] while a similar percentage (54 percent) of adults aged 16 to 64 participate in a formal educational class or program.[7] In coming decades, these numbers will continue to rise as the student population increases and diversifies:

- *Preschool enrollment is increasing*. Enrollment in pre-Kindergarten rose 614 percent between 1985 and 2007, from 0.2 million students to 1.1 million students.[8]
- *Enrollment in Public K-12 schools is increasing.* Public elementary school enrollment (pre-K to 8th grade) rose by 29 percent between 1985 and 2009, while secondary school enrollment increased by 20 percent.[9] Enrollment in public elementary and secondary schools is expected to set new records each year over the next decade, rising from 49.8 million students in 2009 to nearly 54 million in 2018.[10]
- *Post-secondary enrollment continues to rise.* College enrollment set a new record in 2009, with a projected 19.6 million students. Enrollment is expected to continue setting new records from fall 2010 through fall 2018, when it will total 21.3 million students.[11]
- *The student population is diversifying at a rapid rate.* Between 1988 and 2008, the percentage of white students enrolled in public schools fell from 68 percent to 55 percent, while the percentage of Hispanic students rose from 11 percent to 22 percent. During this same period, the percentage of African-American students enrolled in public schools remained almost unchanged, reaching 16 percent in 2008.[12]
- *A significant number of students with disabilities are being served.* In the 2007-08 school year, 6.6 million students were served under the Individuals with Disabilities Education Act (IDEA), comprising 13 percent of total public school enrollment.[13]

Despite the seemingly positive connotations associated with increasing student enrollments, several negative trends persist:

- *A significant number of students continue to drop out of school*. Although U.S. public school graduation rates have generally improved over the past decade, 3 out of every 10 public school students fails to finish high school with a diploma. This equates to 1.3 million students failing to graduate each year.[14] In some urban schools, more than half of students leave school.[15] Completing high school is a prerequisite for admission to college and often has a direct impact on long-term income levels.[16]
- *Demographic disparities exist in high school graduation rates*. According to a 2009 study, over three-fourths of white and Asian students earn a

high school diploma, compared to just 55 percent of Latino, 51 percent of African-American, and 50 percent of Native American students.[17]

- *Considerable demographic achievement gaps exist.* According to a 2009 report, African-American and Hispanic students lag two to three years of learning behind white students of the same age.[18] Likewise, impoverished students (i.e., those eligible for federally subsidized free lunches) are about two years behind their "better-off" classmates of the same age.[19]
- *College readiness among high school graduates is inadequate*. For those who stay in school, the quality of their education has come under increasing scrutiny. Indeed, by some estimates, less than half of students who do graduate from high school are adequately prepared for college or the workforce.[20] Moreover, nearly 40 percent of "all students who enter college must take remedial courses."[21]
- *U.S. students lag behind their international counterparts*. U.S. students have generally underperformed on a number of exams testing a variety of skills,[22] especially those in the math and science fields.[23] According to the Program for International Student Assessment, 17 countries have higher average mathematics test scores and lower income-based inequality than the United States.[24] In addition, the United States has lower high school and college graduation rates than many other industrialized nations.[25]
- *Schools are generally failing to instill 21st century skills in students.* According to one report from 2006, "the future U.S. workforce is…woefully unprepared for today's (and tomorrow's) workplace."[26]

These trends presage a looming, if not current, crisis in the quality of education offered to students of all ages in the United States. A number of solutions have been offered to reverse these trends. Foremost among these have been efforts to increase educational funding at all levels of government. Indeed, some have suggested that additional funding per student is necessary to spur achievement.[27] *However, despite a fourfold increase in funding per pupil over the last four decades, overall student achievement has "remained largely flat."*[28]

At a time of increasing globalization and technological dependence in all facets of life, failure to adequately prepare students will limit their ability to compete for jobs that require not only the mastery of traditional skills, but also a new level of literacy that involves creative, innovative problem-solving and the ability to use a variety of advanced information and communication technologies.[29] As the Federal Communications Commission (FCC) recently observed in its *National Broadband Plan*, "the demands of the new information-based economy require substantial changes to the existing [education] system."[30] Broadband is poised to be the foundation upon which many of these changes will be realized.

1.2 Broadband and Education: Transformative Potential

Broadband-enabled technologies are redefining traditional notions of education and are leading to the development of a new, learner-centric education paradigm. In particular, broadband-enabled technologies:

- Improve the effectiveness of instruction and enhance learning outcomes through more engaging, interactive activities.[31]
- Encourage innovation in how education is delivered, which has resulted in a number of hybrid approaches to teaching (e.g., blended learning).
- Enable a wider array of professional development opportunities for educators and adult learners.
- Enhance access to quality education via distance learning programs, online learning modules, and the availability of relevant content from any location.
- Provide for more individualized learning by allowing students to engage in activities – such as educational modules and video games – that are targeted at refining or bolstering certain skills.[32]
- Enable a range of administrative efficiencies. For example, a number of affordable cloud computing services are streamlining and automating numerous administrative functions.
- Facilitate the collection and analysis of greater amounts of student data to more accurately track student performance.

Such impacts, however, are dependent on the wide availability and robust adoption of broadband and educational technologies inside and outside of the classroom, as well as on the willingness and ability of educators to incorporate these technologies into lesson plans. Unfortunately, there is no "one size fits all" solution to assuring widespread connectivity and utilization of these tools. Educators, administrators, students, and parents face a number of barriers to effectively utilizing broadband for educational purposes.[33] Yet, as discussed below, a number of inventive schools and forward-thinking teachers are using broadband to provide students with effective educational experiences and train them for the 21st century marketplace. In addition, a number of innovative stakeholders, including state and federal policymakers and leaders in the nonprofit sector, are forging creative solutions to integrating new technologies in an effort to disrupt the traditional education paradigm. Closely examining these and other successful approaches yields useful best practices for educators as they continue to integrate new technologies into schools and curricula, and guiding principles for policymakers as they consider reforming rules governing education across the country.

1.3 Overview of the Report

Section 2 provides an analysis of how educators and other stakeholders have leveraged new technologies for educational purposes over the last century. This section also examines how the proliferation of digital technologies like the computer and the Internet has impacted educational environments. The manner in which educators have grappled with new technologies in the past helps inform how new broadband-enabled educational tools can be effectively integrated into modern classrooms.

Section 3 analyzes the current state of broadband availability and adoption across the education sector. This section assesses how students, educators, and administrators are utilizing broadband from preschool to corporate learning environments. The analysis is bifurcated and focuses first on detailing how broadband is being used by stakeholders and then, more thematically, on the array of impacts that these uses are having. Despite an upward trend in utilization and largely positive impacts stemming from these uses, fundamental barriers remain to further integrating these technologies into educational programs.

Section 4 provides a more granular discussion of the array of specific approaches being taken by various stakeholders to further integrate and utilize broadband for educational purposes. This section includes examples from:

- Pre-K through elementary school;
- Middle and high school;
- Higher education (e.g., college and graduate school); and
- Professional development and other adult learning programs.

As a result of these efforts, a vibrantly innovative educational technology industry has developed to provide educational institutions and stakeholders with ready access to an expansive universe of broadband-enabled content, tools, and applications.

Section 5 discusses the near-term and long-term impacts that more robust broadband availability and utilization will have on education. Near-term innovations at the broadband network level will provide more robust connectivity for students in the classroom, at home, and wherever else learning occurs. Several trends stemming from increased connectivity and utilization, including online learning and social learning, are examined. In the long-term, broadband will serve as a platform for significantly shifting the education paradigm toward more individualized and interactive learning experiences, much of which will be accessed and consumed via mobile technologies. In addition, traditional institutions like colleges and universities are being transformed by ubiquitous broadband connectivity. These long-term successes, however, are dependent upon near-term innovations at the network level and the evolution of attitudes toward the use of technology for educational purposes.

Section 6 offers recommendations to policymakers at the local, state, and federal levels on how to overcome barriers to more robust adoption and utilization of broadband in education. A variety of cost-related initiatives, including fundamental reform of the federal E-rate program, will be required to support the significant investments that are necessary in the near-term to provide stakeholders with adequate broadband connections, computers, and other equipment. Additional reforms are necessary to bolster computer access, provide educators with sufficient training to effectively use broadband for educational purposes, and overcome the hesitancy or skepticism of some educators regarding the value of using broadband-enabled technologies in the classroom.

1.4 Foundational Principles

A number of *foundational principles* are discussed throughout this report and should drive public policymaking vis-à-vis broadband in education:

- Education in the United States is at a critical crossroads as the quality of education and student achievement continues to stagnate.
- Broadband is an essential component in shifting the current educational paradigm from closed, static, teacher-centered methods of education and toward learner-centered models that are more interactive, individualized, and openly accessible to all.
- Broadband is facilitating the development of a new generation of educational tools, services, and devices, which are reshaping the delivery of educational services and enabling significant benefits for students, teachers, and institutions.
- Broadband expands access to educational resources for teachers, creates efficiencies in the administration of education, and bolsters efforts to collect and analyze student performance data.
- An array of public and private sector initiatives is spurring innovation, deployment, and use of broadband-enabled education services across the nation. Public-private partnerships geared toward delivering equipment and services have been particularly effective at increasing the use of technology for educational purposes.

- Opportunities exist for local, state, and federal government to implement adaptive policies and practices that encourage continued innovation and use of broadband technologies in education. These include increased and more targeted funding for new and existing efforts, as well as the implementation of a forward-looking strategy for technology integration.

2. Educational Technology: Why it Matters & The Role of Digital Technologies in Modern Education

Over the last century, many new and emerging technologies have been adapted for use in education.[34] This section first provides an historical overview of these uses and assesses their impacts. Understanding how educators experimented with using new technologies for instructional purposes and the scope of their impacts on traditional educational paradigms provides relevant context for assessing current efforts centered on leveraging digital technologies – e.g., computers and broadband – to enhance education in the United States.

This section then examines how two specific digital technologies – the computer and the pre-broadband Internet – have impacted the way students learn and how educators teach. The myriad issues and concerns associated with using digital technologies in modern educational settings offer a number of insights and "lessons learned" for broadband policy in the education arena.

2.1 Why Technology Matters in Education: An Historical Analysis

Throughout the 20th century, new communications and mass media technologies had profound impacts on how education is structured, delivered, and consumed. Indeed, in the early part of the century, radio, film and television quickly emerged as viable mediums for the delivery of educational content and enabled significant change in traditional notions of teaching and learning. For example, film and radio were initially employed during the First and Second World Wars to train the nation's military[35] and to develop a skilled workforce at home.[36]

After the Second World War, a rising birthrate and rapidly swelling public school enrollment spurred a reevaluation of past instructional methods, which resulted in a revamped approach to school curricula – one that began to incorporate available technologies to supplement classroom activities.[37] By mid-century, television had emerged as a practical medium for instruction.[38] Also during this period, film was frequently used in schools for the depiction of historical events,[39] while radio was used to provide recordings of classroom lectures, weather reports, and other such productions.[40]

The rapid adoption and use of these technologies for educational purposes spurred further inquiry into the effectiveness of these tools and their impacts on learning.[41] Over the next several decades, the resulting studies yielded important insights and helped educators devise new ways of using media to deliver educational content in an array of contexts.[42] *While some reluctant educators saw little value in incorporating these types of technologies into instruction,*[43] *there was a clear trend in using new media to enhance educational instruction and learning both inside and outside of school*. Foremost among these efforts was the push to leverage the ubiquity of television to deliver relevant content directly into the home.

Perhaps the most significant contribution to this emerging body of research was a report commissioned by the Carnegie Corporation regarding the "potential uses of television in preschool education." Authored by Joan Ganz Cooney, this paper built the foundation upon which *Sesame Street* was eventually developed and produced.[44] Among the many key observations and recommendations included in this paper, Cooney stressed the importance of using media – i.e., television – to "intellectually stimulate" preschool-aged children in order to ensure that a broader swath of them were ready for Kindergarten.[45] Television was a key medium because of its ubiquity, its popularity, and its ability to both entertain and educate via a carefully constructed format. Moreover, television was seen as a potentially interactive mass medium that could be leveraged to help in the development of critical skills among young viewers.[46]

In addition to positively impacting student performance in school,[47] *Sesame Street* and its progeny of educational television programs impacted in-classroom teaching methods.[48] Indeed, a study from 1974 found that these types of programs were influencing how educators taught children in Kindergarten and first- and second-grade.[49] Educators were encouraged to build upon and incorporate the lessons and themes included in these programs into their own teaching methods and curricula.[50] Even today, as computers and Internet connections continue to diffuse across the globe, some feel that television remains one of the best and most reliable educational technologies available.[51]

The popularity and effectiveness of many of these innovative approaches fostered the creation and growth of a vibrant marketplace for educational technology that, to this day, continues to thrive and proliferate. For example, as discussed below, this market has been adept at evolving parallel to the communications and information technology sector and providing parents, teachers, and students with innovative new tools like educational software and games.[52] As a result, these types of technologies have become a critical component of educating students from preschool through college.

These and other modern educational technologies have impacted traditional notions of education in a number of ways, including:

- Extending learning into the home;
- Supplementing traditional in-school education with targeted content tailored to the needs of children of a certain age or demographic group;
- The production and wide-scale dissemination of engaging and interactive educational content;
- Increased experimentation among educators regarding how to best use technology in the classroom and how to build upon the lessons being learned by students at home;
- The importance of leveraging technologies to aid in the development of critical skills before entrance into formal schooling; and
- The creation of a marketplace for educational technologies, which has spurred healthy competition and robust innovation.[53]

Despite the many positive impacts of these technologies and the new teaching methods they have inspired (see sections 3 & 4), challenges to further incorporating technology into the teaching and learning paradigm exist. Indeed, institutional resistance to change and a number of other human factors have often prevented the large-scale implementation of such tools (see section 3).[54] The emergence and increasing prevalence of a variety of digital tools – notably the computer and the Internet – have begun to assuage some of these concerns and to correct some of these negative perceptions.

2.2 The Emergence of Digital Technologies & Their Impacts on Education

In the past several decades, a second generation of educational tools – digital technologies like the computer and the Internet – has further reshaped traditional teaching and learning paradigms. Understanding how teachers, students, and parents adapted educational techniques and expectations to successfully leverage these technologies informs how broadband and broadband-enabled tools should be further integrated into the modern educational paradigm.

2.2.1 The Computer

Computers became increasingly commonplace in educational settings beginning in the late 1960s and 1970s.[55] Early uses of computers were focused primarily on "mathematics, science and engineering."[56] Educators and researchers eventually began to expand these uses by developing programs that used the computer as a way to teach and enhance reading and as a medium for more individualized instruction.[57] Other efforts focused on assessing the impact of the computer on learning outcomes. One study from this era found that computer-based education could "increase [test] scores from 10 to 20 percentile points and reduce time necessary to achieve goals by one-third."[58] As such, "researchers were looking for new educational paradigms to take advantage of breakthroughs in computer technology" throughout much of this time period.[59]

The number of schools with computers continued to increase throughout much of the 1980s and 1990s, but their integration into instruction was fragmented because of the low number of computers per school. In 1981, about 18 percent of public schools had at least one computer for instruction; by 1990 that number grew to 97 percent.[60] However, the median number of computers in these schools was just three for K-6 schools and 16 in high schools in 1985.[61] As a result, students were not exposed to computers on a regular basis. For example, in 1987, students used the computer for just one hour per week on average.[62] In addition, educators were using the available computers to teach basic skills like word processing[63] and for "rote learning through drill-and-practice programs."[64] By the 1990s, the number of computers in schools continued to increase, but a survey of teachers in 1995 found that computers were still not widely used for instructional purposes.[65] In addition, one report found that just half of all teachers had taken part in professional development for technology usage in the classroom.[66] Yet, despite these trends, educational technology was "perceived as a major vehicle in the educational system reform movement."[67]

During this period, schools began to investigate the impacts associated with providing each student with a computer. So-called "one-to-one" (or 1:1) computing began in earnest in the United States in 1997 when Microsoft launched its "Anytime Anywhere Learning" program, which partnered with some one thousand schools to deploy laptops to each student.[68] Even though this program eventually floundered as a result of many schools being unable to sustain 1:1 initiatives, laptop use continued to expand in schools, replacing bulky and outdated desktop computers.[69] Currently, about 6 percent of public schools[70] and 12 percent of higher education institutions provide laptops to individual students.[71] These numbers will likely rise over the next few years as initiatives supported by federal stimulus funding are deployed (see sections 5 and 6). Moreover, some states have gone so far as to mandate 1:1 computing in schools (see Case Study #1).[72]

CASE STUDY #1
Maine's One-to-One Laptop Initiative

Maine was the first state in the country to implement a 1:1 computing initiative on a state level. In 2001, the state convened a Task Force to recommend how best to structure and deploy this program. The Task Force recommended that the state "pursue a plan to deploy learning technology to all of Maine's students and teachers in 7th and 8th grade and then to look at continuing the program to other grade levels." The program was officially launched in 2002 after passage of a state law that created a Technology Endowment to fund the program.

The impacts of this initiative have been closely studied by researchers. A report issued after the program's first phase (2002-2004) found ample evidence of positive impacts and concluded that "there is already substantial self-reported evidence that student learning has increased and improved." Subsequent studies have consistently found positive impacts on overall learning outcomes and student enthusiasm. Moreover, several pilot programs leveraging the 1:1 initiative have resulted in positive impacts on the teaching and learning of science and math.

In addition to assessing the positive impacts of this statewide initiative, the state and several research institutions have identified best practices associated with effectively implementing 1:1 computing initiatives. These include ensuring adequate teacher teaching, providing ongoing professional development, and making technical support resources widely available.

The impacts of one-to-one computing have been closely studied for much of the past decade. Even though some have argued against the "technotopian" vision underlying 1:1 computing,[73] many studies have found that well-designed initiatives can have positive impacts on student learning and educational performance. For example, a 2005 study found that students with personal laptops "tended to earn significantly higher test scores and grades for writing, English-language arts, mathematics, and overall Grade Point Averages."[74] Another study compared schools with 4:1, 2:1, and 1:1 student-computer ratios, and found that a 1:1 ratio had a number of advantages.[75] The study found, for example, that students with a laptop used the computer more frequently at home for academic purposes and received less large group instruction in a one-to-one learning environment.[76] A 2006 study observed that a key component of successful 1:1 initiatives was an engaged teaching faculty that viewed the laptops as a positive learning tool.[77] A series of studies published in January 2010 confirmed many previous findings.[78] The general conclusion across each of these studies was that, even though there are many variables involved in effectively deploying a 1:1 laptop program,[79] those initiatives that allowed students to take their computers home had the largest impact on performance.[80]

Laptops and other individual computing devices (e.g., cellphones and smartphones) are increasingly leveraging wired and wireless broadband networks to further enhance the overall learning experience of students (see sections 3 and 5 more additional discussions).

2.2.2 The Internet

Although the Internet was first developed in the 1960s by the U.S. Department of Defense in collaboration with several research institutions,[81] it took until the 1990s for primary and secondary schools to begin adopting and using this important technology.[82] Indeed, only 35 percent of public schools were connected to the Internet in 1994.[83] However, as a result of wide commercial appeal and rapid consumer adoption of this technology, along with federal funding via the E-rate program, the percentage of public schools that were connected to the Internet exploded in the late 1990s, reaching 95 percent in 1999 and 100 percent in 2003.[84] Internet at the classroom level also increased exponentially over the same period of time, rising from just three percent of public school instructional rooms in 1994 to 94 percent in 2004.[85] However, the number of public school computers with Internet access available per student remained low through the end of the century.[86]

Despite these limitations, the Internet showed significant potential in education. For example, the emergence of the World Wide Web in the 1990s provided access to "an unprecedented volume of information" for use in teaching and learning regardless of location.[87] As a result, educators at every level began to explore how to use the Internet in their instruction, and innovators developed new tools that leveraged this new technology. National Geographic's KidsNet, for example, was created in 1987 to foster inquiry-based learning amongst elementary school children.[88] Through the program, students performed scientific experiments, analyzed trends, and communicated with practicing scientists through e-mail, and sent the results of their experiments to be combined with national and international results. The vast majority of participating teachers – more than 90 percent – found that "using KidsNet significantly increased students' interest in science, and that their classes spent almost twice the amount of time on science than they otherwise did."[89] By 1991, KidsNet was being used in over 6,000 classrooms in 72 countries.[90] These types of online tools demonstrated the potential for computers and the Internet to "create a global classroom."[91]

During this same period, the Internet was increasingly used to deliver educational courses and content to remote areas. Between 1994 and 1995, enrollment in distance education courses in higher education nearly doubled.[92] Further, 78 percent of public four-year higher education institutions offered distance learning at this time.[93] Distance education was widely viewed as a "low-cost means of providing instruction to students who might not otherwise have had access,"[94] and served as a precursor to current broadband-enabled online educational models (see section 3).

2.3 Conclusions

The potential impacts of technology on education have long been subject to hyperbole. For example, Thomas Edison in the 1920s predicted that "the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks."[95] Similarly, a 1982 article in *Time* magazine hailed the arrival of "microcomputers" and heralded an "electronic revolution" in the education of young children.[96] Despite these misguided predictions, technology has always played an important role in education. *Among other things, new technologies challenge the status quo and spur innovation in teaching and learning.* More recently, the availability of more affordable computers and access to an expanding Internet of Web content has spurred rapid adoption and use of digital technologies in educational settings across the continuum.

Technology is thus an important and vital component of education so long as it is effectively integrated. Experimentation in 1:1 laptop programs and online learning is still ongoing, and the emergence of robust broadband networks is driving similar innovation in schools and homes across the country. *As discussed in section 3, broadband is having wide and profound impacts on the education sector and is poised to fulfill the promise of its technological predecessors.*

3. Broadband & Education: Assessing Broadband Adoption & Analyzing the Impacts of its Use Across the Continuum of Education

Broadband Internet access is poised to fundamentally alter the education paradigm in the United States. Indeed, several recent inquiries by federal agencies like the Federal Communications Commission (FCC) and the U.S. Department of Education (DOE) have positioned broadband as an essential component of 21st century learning. For example, U.S. Secretary of Education Arne Duncan has stated that "broadband access and online learning…presents a huge opportunity that can be leveraged in rural communities and inner-city urban settings, particularly in subjects where there is a shortage of highly qualified teachers. At the same time, good teachers can utilize new technology to accelerate learning and provide extended learning opportunities for students."[97] To this end, robust connectivity to and effective utilization of broadband is at the heart of the DOE's *National Education Technology Plan.*[98] Similarly, the FCC has observed that broadband "can be an important tool to help educators, parents and students meet major challenges in education. The country's economic welfare and long-term success depend on improving learning for all students, and broadband-enabled solutions hold tremendous promise to help reverse patterns of low achievement."[99]

The potential impacts of effectively harnessing the numerous broadband-enabled tools and applications for educational purposes are enormous across the continuum. Yet, despite its seemingly limitless upside, several barriers exist to further adoption and use of these technologies by educators and institutions. Indeed, the FCC has observed that "the education community needs better aligned incentives to realize the potential of broadband in schools."[100]

Section 3.1 assesses current levels of availability and adoption of broadband in education. Accurately gauging these levels assists in identifying gaps that exist between schools that are actively leveraging broadband for student gains inside and outside of the classroom and schools that have access to broadband but that, for whatever reason, have chosen not to utilize it. This section also identifies several barriers to more robust adoption and utilization of broadband by schools, teachers, and students.

Section 3.2 providers a more granular analysis of how broadband is being used and how it is impacting users. In particular, this section assesses levels of use by and impacts of broadband on:

- Students from pre-Kindergarten through High School;
- K-12 Educators;
- Students and Educators in Higher Education;
- The Administration of Education; and
- Adult Education.

* * * * *

3.1 The Availability and Adoption of Broadband in Education

As discussed in section 2, digital technologies have transformed how educational content is delivered, used, and consumed by educators, parents, and teachers. Broadband-enabled educational tools, devices, and applications are having enormous impacts on students from pre-Kindergarten through adult education courses (these impacts are discussed in section 3.2). However, in order for the full range of benefits to be realized, such technologies must be universally available and adopted on a wide scale by all stakeholders in the education space.

This section examines a wide array of data to assess current levels of availability and adoption of broadband for educational purposes. Even though broadband is widely available and is increasingly being adopted by schools and households, *significant gaps remain between adopters and non-adopters.* As such, this section also explores the various factors impeding more robust adoption and utilization of broadband in schools and at home (section 6 articulates recommendations for overcoming these barriers).

3.1.1 Availability of Broadband for Education

Deployment of broadband has progressed considerably in recent years, due largely to intense competition among broadband providers and the current regulatory framework. Indeed, several recent studies released by the FCC have found that broadband is available to nearly every household in the United States.[101] Moreover, recent research suggests that lack of available broadband prevents just a small percentage – some four percent – of the population from accessing the Internet.[102] Yet, even though broadband providers continue to invest billions of dollars in physical infrastructure,[103] broadband service still remains relatively scarce in some areas with very low population densities.[104] Overall, however, broadband is widely available to schools, universities, households with children, and other stakeholders who wish to use their Internet connection for educational purposes.[105]

In order to spur broadband deployment to truly unserved areas of the country, the federal government has placed a national priority on network build-out to these parts of the country. To this end, billions of dollars were included in a 2009 federal stimulus bill for broadband network build-out.[106] In addition, the FCC has issued a rural broadband strategy to spur deployment and adoption in these areas; enhancing educational opportunities in these areas via broadband is a key component.[107] Existing programs – e.g., the Distance Education and Telemedicine Program administered by the Department of Agriculture's Rural Utilities Service – also provide funding and other support for broadband deployment and adoption for educational purposes in rural areas.[108] As discussed in section 6, targeted policymaking and market-driven efforts will be critical to further expanding the availability of broadband.

3.1.2 Adoption of Broadband in Education

Large-scale deployments of computers and basic Internet access in educational institutions across the country over the past decade have positively impacted adoption of broadband in most contexts. Indeed, many school districts have "invested heavily in the infrastructures required to accommodate computers and the Internet [and have] commandeered resources to purchase software and technical support for students and staff."[109] As a result, broadband adoption rates in educational settings across the continuum have grown rapidly in recent years. *Yet, despite such improvements, research suggests that many educators still lack the necessary technical support and professional development for effective classroom instruction.*[110] *In addition, low per-student bandwidth rates and lack of adequate computer access may inhibit greater adoption and usage of broadband for educational purposes.*[111]

Nearly all schools in the United States are currently connected to the Internet. Estimates regarding school Internet connectivity range from 97 percent[112] to 100 percent.[113] Of those public schools with Internet access, 97 percent used broadband connections to access the Internet in 2005, up from 80 percent in 2000.[114] Yet, even though many schools report broadband connectivity, most of these connections support many concurrent users.[115] As a result, the bandwidth available per student is often very low and significantly below the minimum threshold that the FCC has designated as basic broadband.[116] One study has estimated the national average access speed per student to be just 6.5 Kbps.[117] At these speeds, many of the potential cost-savings, quality improvements, and cutting-edge educational applications are inaccessible.[118]

A fundamental barrier to more robust broadband adoption is a lack of adequate computer access in some schools. By fall 2008, there was an average of three instructional computers per classroom in schools across the United States.[119] Approximately 58 percent of schools supplemented these computers with laptops on carts, which can be wheeled from classroom to classroom as needed.[120] Only six percent of schools made computers available to students to take home.[121] A 2008 study found that over 54 percent of public school teachers reported having two computers or less in their classrooms and observed that this number is inadequate to effectively use computers for instructional purposes.[122] A variety of individual computing approaches, including 1:1 laptop programs, have been launched in recent years to close this gap (see section 2.2.1).

School and classroom access to computers is critical since many students lack such equipment and broadband connections at home. While home broadband adoption and computer ownership rates have consistently increased over the last several years, certain demographic groups still lag behind. Fully 75 percent of parents with a minor child in the home had broadband access in 2009, compared to the 65 percent national average reported by the FCC.[123] Despite this, *the adoption rates of African-Americans and low-income families still lag behind the general population*. Only 56 percent of African-Americans and 45 percent of households with incomes under $30,000 had adopted broadband by early 2010, compared to 66 percent of all adults.[124] Children in these households are thus more likely to be without a broadband connection than most other demographic groups.[125] As a result of these disparities in home connectivity, some students are more dependent upon utilizing the Internet at school and in the library. Indeed, low-income students,[126] African-American, and Hispanic children utilize the Internet from school much more regularly than other children.[127]

The costs associated with adopting and integrating broadband-based programs and services, such as 1:1 laptop programs and more robust broadband connections, may be prohibitive for many schools and universities. According to one estimate, technology integration programs can cost $15,000 per classroom and have a four-year lifespan.[128] This would total $150 per student per year in a classroom of 25 students.[129] Moreover, the initial implementation costs for broadband access can range from several thousands of dollars to hundreds of thousands of dollars depending on a variety factors including the type of connection and the number of students served.[130] For many schools, these initial development and delivery costs are a significant barrier to greater broadband adoption.[131] In addition to implementation costs, the amount of time it takes to integrate new technologies into the curriculum and train teachers to become comfortable with the tools can significantly add to program costs.[132] Schools are overcoming such high expenses in innovative ways. Many are applying for grants and working with private organizations that agree to sponsor a classroom or school.[133] Others use E-rate funds, while some schools are beginning to allow students to bring their own devices to school.[134]

Cost issues are further exacerbated by a lack of targeted federal funding mechanisms. Though schools receive funding from a variety of sources – including the Enhancing Education Through Technology (EETT) Program (Title II, Part D of the No Child Left Behind Act), the federal E-rate program, broadband-specific stimulus funds, and education-specific stimulus funds – several issues may prevent schools from benefiting from these funds. These issues include a lack of funding overall, concerns regarding the eligibility of schools for federal funding, a lack of targeted allocation mechanisms, and cumbersome application procedures. Several recent initiatives and proposals, including the U.S. Department of Education's Race to the Top program, offer promising approaches to encouraging and rewarding innovation (see section 6 for further discussion).

"I have just one computer in my classroom, though there are thirty students. And students are unable to access it, as it is situated on my desk. The computer lab is also ill-equipped for instructional purposes. So it's difficult to incorporate technology in the classroom when there aren't enough resources to go around."

~ Steve, Teacher, 9th Grade Geography, GA

Additional barriers impede more robust adoption of broadband for educational purposes. These include lack of training and other support for teachers to effectively use broadband in their instruction, a variety of organizational barriers that may be holding educators and schools back from using technology more frequently, and an overall lack of clear standards for encouraging the development of 21st century skills among students of all ages (these are discussed in more detail section 3.2).

3.2 Uses and Impacts of Broadband in Education

Over the last decade, broadband has begun to fundamentally change the way millions of students are educated both inside and outside of the traditional classroom setting. Students of all ages are able to access vast amounts of educational content online for use in the classroom, during other school-related activities, at home, and for personal exploration. In some cases, broadband-enabled learning has replaced the traditional classroom entirely, as evidenced by the fact that many students utilize high-speed Internet connections to take classes and complete advanced degree programs online.

Educators are using broadband-enabled tools to augment classroom curricula and provide more individualized, interactive, and real-world learning opportunities via a variety of blended learning approaches.[135] Educators are also able to access professional development resources through the Internet to enhance their instruction. Similarly, institutions of higher education are improving access to educational content by providing both free course material and traditional coursework for enrolled individuals online.

This section provides a comprehensive survey of how broadband is being used by and the impacts that these uses are having on stakeholders in an array of educational contexts, including:

- Pre-K to 12th Grade Students;
- Educators;
- Higher Education;
- Administrative Functions; and
- Adult Learners.

3.2.1 Broadband and Pre-K to 12th Grade Students

Students from pre-Kindergarten through high school are using broadband to pursue a wide array of activities online, which are enabling a number of improvements in student learning. This section: (1) provides a broad overview of these uses, and (2) assesses their impacts on students from pre-Kindergarten through high school. Snapshot #1 provides a brief overview.

SNAPSHOT #1
Uses & Impacts of Broadband Among
Students in Pre-K through 12th Grade

Uses	Impacts
▪ Gaming ▪ Online learning ▪ Blended learning ▪ Mobile learning	▪ Increased number of learning environments ▪ Enhanced opportunities for disabled students ▪ Personalized instruction ▪ Enhanced learning outcomes ▪ 21st century skill development

3.2.1.1 Usage among Pre-K to 12th Grade Students

Technology is an integral part of academic life for many students. In 2005, 96 percent of children ages 8 to 18 had gone online.[136] Seventy-four percent had Internet access at home, and 61 percent used the Internet on a daily basis.[137] Over the last five years, overall media consumption by children in this age range has increased dramatically. A study released in 2010 found that children in this age group consume nearly eight hours of media each day.[138]

Technology and broadband use among younger children in particular is increasing rapidly. A study from 2007 found that 2 percent of households with newborns and children aged 1 to 4 had a computer with Internet access in those children's rooms, and 4 percent had computers with Internet access in the rooms of children aged 4 and 5.[139] About half of children age six or younger had used a computer, and 27 percent of children ages 4 to 6 spend over an hour at a computer each day.[140] Not surprisingly, children age 6 or younger spend nearly the same amount of time consuming digital media as they do playing outside.[141]

Teenagers have the highest Internet usage rates of any other age group.[142] Of the 93 percent of teenagers that are online, 63 percent go online daily.[143] Seventy-seven percent go online from schools.[144] Teenagers typically use broadband to communicate with peers, participate in educational activities, and complete school assignments. Indeed, 87 percent of teenagers ages 12 to 17 utilize electronic personal communication, in the form of text messaging, sending emails or instant messages, and commenting on social networking sites.[145] Ninety-four percent of teens use the Internet for school-related research, and 48 percent report doing so once a week or more.[146] In addition, more than half of teens are more likely to revise and edit their work when writing with a computer.[147] Indeed, broadband-enabled tools have become so integral in daily life for most teenagers that parents have begun "digitally grounding" their children by suspending access to the Internet and cellphones.[148]

Teenage participation in other types of online activities, however, is less intensive than older and younger cohorts. For example, only eight percent of teenagers visit virtual worlds[149] and actively use Twitter.[150] In addition, teens have proven to be fickle when it comes to using certain types of online tools that could develop critical skills, like writing. For example, the percentage of online teens who maintain a blog decreased from 28 percent to 14 percent between 2006 and 2009.[151]

Broadband-enabled technology is thus a critical and increasingly indispensible component of daily life for digital "natives," students who "live most of their lives online."[152] As a result, students are using broadband and broadband-enabled tools in a variety of ways to enhance their education at home and in school. The following provides an overview of some key uses.

- **Gaming**

Casual game playing is an extremely popular activity for students. According to a recent report, three-fourths of American children play computer and video games.[153] Such tools have been shown to help children master course content and develop 21st century skills such as literacy and complex problem solving.[154] Moreover, such activities "allow teachers to tap into students' enthusiasm for digital games to engage, expand, and empower them as learners."[155] Seventy percent of casual gamers believe that games provide valuable educational benefits.[156] To illustrate, a study by the Education Development Center found that preschool students "developed early reading skills when their teachers used videos and interactive games from public television shows in the classroom."[157]

Participation in multiplayer virtual worlds is an increasingly popular trend among younger users. These games typically involve three-dimensional computer-based environments that allow first-person interaction with educational content.[158] These range widely in terms of scope and complexity. Basic offerings for young children include Disney's *Club Penguin* and *Whyville*.[159]

- **Online Learning**

Overall, a significant number of K-12 students are participating in online learning programs that provide individual courses, programs of study, and tutoring services over the Internet. A survey released by the U.S. Department of Education in 2009 estimated that more than one million K–12 students took online courses during the 2007 school year.[160] This figure is expected to increase as demand for these programs rises. A study from 2007 suggests that there is a fair amount of pent up demand for online learning programs. This study of educators, parents, and students from across the country found that more than half of high school students and one-third of middle school students "[were] interested in taking courses online that [were] not offered at their schools."[161] By 2019, about 50 percent of all courses may be delivered online.[162]

- **Blended Learning**

Blended learning programs, which combine online learning with face-to-face instruction, are also being utilized.[163] Through such programs, students are able to access high quality educational content via broadband regardless of location, income level, and other lifestyle factors. To this end, some teachers are using Web 2.0 technologies like blogs, wikis, and Twitter to supplement in-classroom learning.[164] For example, a high school teacher at the University Laboratory High School at the University of Illinois has asked students to comment on Dante's *Inferno* via Twitter.[165] Educators are increasingly using these types of approaches to leverage student interest in these types of tools for educational purposes (see section 3.2.2)

- **Mobile Learning**

With each passing year, cellphone ownership rates among children and teenagers increase dramatically.[166] Some two-thirds of all children between the ages of 8 and 18 "own their own cell phone, up from 39 percent five years ago."[167] Thirty-one percent of children aged 8 to 10 have their own cell phone, compared to 69 percent of 11-14-year olds and 85 percent of children between the ages of 15 and 18.[168] Mobile learning uses handheld devices to provide learning "anywhere, anytime," reach underserved students, improve "21st century social interactions," link students to online learning environments, and deliver more personalized learning experiences.[169] Through broadband-enabled smartphones like the iPhone and Droid, students are able to engage in a number of activities, such as accessing course assignments, completing activities, playing games, reading educational materials, and communicating with teachers and classmates.

3.2.1.2 Impacts on Pre-K to 12th Grade Students

The many and varied uses of broadband by students in pre-Kindergarten through high school have had discernible impacts on student achievement and development of real-world skills. This section identifies many of these impacts.

- **Increases the Number of Learning Environments**

Increased and diverse utilization of broadband by students, via formal channels (e.g., in the classroom) and via informal channels (e.g., at home), diversifies and increases the number of learning environments for educators, parents, and students. For example, since educational information is increasingly shared through online social networking and virtual communities, teachers are leveraging the popularity of these tools to supplement in-classroom learning by using an array of Web 2.0 tools such as wikis, blogs, videoconferencing, and podcasting.[170] These tools can be used to enable a variety of blended learning experiences, including virtual work teams, which allow individuals to work together on specific projects.[171] Case Study #2 provides an example.[172]

CASE STUDY #2
<u>The Virtual Hall of Science</u>

The New York Hall of Science and the Greater Southern Tier BOCES SciCenter program have launched a program aimed at working with ethnically and economically diverse young people to create a Virtual Hall of Science (VHOS). This group will collaborate to design and build the VHOS and maintain it after launch. Participants will be "trained as exhibit designers, builders, active exhibit guides and mentors." The goal of this project is to teach students much-needed science, technology, engineering and math (STEM) skills, as well as provide them with hands-on experience with information and communications technology."

The program will employ 20 high school "Explainers" and 20 middle school students, while engaging hundreds more through an online virtual world that will support the VHOS. Participating students will receive 70 hours of training in order to develop and launch the VHOS. Students will also train middle school students, create a management plan, and perform a beta test with their families before the public launch. The skills learned and developed through this project are those have been identified as critical for 21st century readiness by the International Society for Technology in Education. These include creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem solving and decision making, digital citizenship, and technology operation concepts. In addition, the project is expected to advance knowledge of virtual environments as an educational and workforce preparation tool.

Additional information can be found at: http://www.nysci.org/learn/research/vhos.

Broadband-enabled online learning programs are also having discernible impacts on students. By offering courses and programs of study over the Internet, students are provided greater choice and flexibility. Advanced learners are no longer limited by the courses offered by their school and can obtain the coursework they need through online opportunities.[173] Indeed, a recent survey of over 10,000 school districts found that 70 percent of respondents viewed distance learning as important for expanding access to courses not currently offered in their schools, while sixty percent cited the importance of distance learning for access to AP courses.[174] Moreover, recent studies suggest that "online high school graduates are twice as likely to go to college as those who are not online."[175]

- **Enhances Educational Opportunities for Disabled Students**

The flexibility and ubiquitous nature of broadband-enabled learning is of particular importance to students who may have a limited ability to travel or who otherwise require home schooling. For many people with disabilities, online learning is critical.

According to the U.S. Department of Education, 13.4 percent of school children – approximately 6.6 million – participated in some kind of disabilities program in the 2007-08 school year.[176] In general, people with disabilities have completed less schooling than people without disabilities[177] and, as a result, earn less as a group than people without disabilities.[178] Broadband enables a wide array of educational opportunities for students with disabilities, including online learning and access to a variety of specialized services.[179] In addition, a number of the assistive technology features found on computers can provide students with disabilities the same access to course material as their non-disabled peers.[180]

- **More Interactive & Personalized Instruction**

Broadband-enabled educational tools enable more interactive, personalized instruction, which has been found to improve learning outcomes.

Traditional classrooms often lack in interactivity. With an average of less than 0.1 questions asked per hour, students often become disengaged and disinterested.[181] Through the innovative use of broadband, however, it is possible to "provide learners with anytime, anywhere content and interactions."[182] Indeed, computer-based instruction and tools utilized outside of the classroom encourage students to ask questions, retain student attention, and tailor content to meet various learning styles.[183] Rather than just having information fed to them from the teacher or via textbooks, students are able to actively participate in the learning process.[184] Tools such as gaming and virtual role-playing allow students to step into their textbooks and interact directly with the material and with other individuals to bolster the learning experience.[185]

Students are further engaged when instructors use technology to personalize instruction. To this end, it has been observed that "computers offer a way to customize instruction and allow students to learn in the way they are best wired to process information, in the style that conforms to them, and at a pace that matches their own."[186] This is particularly valuable for underperforming students, English language learners, and students with disabilities.[187] Several barriers, however, are holding back the creation and dissemination of more robust online educational content.[188] These are discussed in more detail in section 6.

▪ Enhances Learning Outcomes

Studies have consistently found that Internet-based technologies and tools enhance learning outcomes. For example, a 2002 study found that, in households with broadband connections, "children ages 6-17 reported that high-speed access affected both their online and offline activities, including schoolwork."[189] According to this study, since getting broadband, 66 percent of participating children spent more time online, 36 percent watched less TV, and 23 percent [improved their] grades."[190] Moreover, a recent report by the U.S. Department of Education concluded that, "[o]n average, students in online learning conditions performed better than those receiving face-to-face instruction."[191] Additional studies have found similarly positive impacts of Internet usage on student achievement in reading, literacy, mathematics, and science.[192]

A number of other studies have found that increased computer and broadband utilization among low-income households have particularly discernible impacts on learning outcomes. For example, a study by the American Psychological Association found that low-income children who used the Internet on a regular basis performed better on standardized tests of reading achievement and had higher grade point averages than did children who used it less.[193] A study of the Computers for Youth model, which provides low-income families with discounted laptops and Internet connections, also found a positive correlation between increased computer and Internet use and improved test scores.[194] (This model is discussed in more detail in section 4.1.5).

Moreover, several programs have seen marked improvements in learning outcomes as a result of Internet usage. For example, students at the Florida Virtual Schools outperformed other students on AP tests and scored 15 percentage points above the average on the state's standardized assessment test for 6th – 10th graders.[195] In Oregon, the Salem-Keizer School District has been able to re-enroll over half of high school dropouts and at-risk students through its online Bridge Program each year.[196]

▪ Promotes Development of 21st Century Skills

Broadband-enabled educational technologies play a critical role in the development of 21st century skills (see Snapshot #2).[197] Ensuring that these skills and digital literacy skills inure in students across the continuum will position the United States for continued economic prosperity in coming decades. As the FCC recently observed, "digital literacy is a necessary life skill, much like the ability to read and write."[198]

Snapshot #2

Defining 21st Century Skills

Many agree that developing and honing 21st century skills is essential for all students in the United States in order to assure that they are able to compete in the global marketplace. In addition, there is wide agreement on the types of skills these will entail (e.g., creative thinking). Several organizations offer various definitions of what the full set of 21st century skills should encompass. Despite some minor differences, the following organizations agree that digital literacy is a central component of the 21st century skill set.

The Partnership for 21st Century Skills (www.21stcenturyskills.org) has articulated a framework for 21st century learning outcomes to help students garner the skills they will need to succeed in the 21st century work force. The outcomes that students should master for future success include: core subjects (e.g., English, government, and economics); 21st century themes (e.g., global awareness); learning and innovation skills (e.g., critical thinking); information, media, and technology (e.g., digital literacy); and life and career skills.

Reasoning that the "sheer magnitude of human knowledge, globalization, and the accelerating rate of change due to technology necessitate a shift in our children's education from plateaus of knowing to continuous cycles of learning," the North Central Regional Educational Laboratory and the Metiri Group have devised a similar framework that encompasses a critical set of skills for 21st Century students. These include: digital age literacy, inventive thinking, and high productivity.

By engaging students more directly in the learning process, students are able to more quickly master course content and become adept at problem solving and participating in the creation of their own content via various forms of media.[199] A variety of programs have been launched to support such skill development. For example, ThinkFinity, a Web-based educational portal supported by the Verizon Foundation, has aggregated a number of resources dedicated to driving 21st century skill development.[200]

Another unique approach is the Online Leadership Program by Global Kids.[201] This program "integrates a youth development approach and international and public policy issues into youth media programs that build digital literacy, foster substantive online dialogues, develop resources for educators, and promote civic participation."[202] In particular, Global Kids engages students in skill development via gaming, virtual worlds, digital media creation, and participation in Internet-based dialogues. Regarding the latter approach, participants in the Leadership Program are able to contribute to Newz Crew (http://newzcrew.org), which is an online discussion forum by and for students that hosts interactive conversations on an array of local, national, and global issues.

3.2.2 Broadband and Educators

Broadband is enhancing the quality and effectiveness of instruction and improving the delivery of education for teachers. Snapshot #3 provides a brief overview of how educators are using this technology and how it is impacting their ability to educate students. However, a number of challenges must be addressed before the full range of broadband-enabled tools is more fully integrated into curricula, classrooms, and schools across the country.

SNAPSHOT #3
Uses & Impacts of Broadband Among Educators

Uses	Impacts
▪ Access critical curricular & professional development resources	▪ Enhanced curricula
▪ Participate in professional development	▪ Resource sharing
▪ Planning	▪ Increased effectiveness
▪ Web 2.0 tools	▪ More interactive classrooms

3.2.2.1 Usage among Educators

Broadband enables a variety of beneficial applications for teachers. However, despite increasing utilization of many of these tools, several barriers are impeding more robust adoption. This section highlights key uses and identifies major obstacles to further use of broadband by educators.

- **Access Curricular & Professional Development Resources**

Educators are using broadband to access online information in an effort to enhance curricula, improve teaching methods, and participate in professional development programs delivered online. Many Web sites provide curriculum, lesson planning, and social support for teachers of all grade levels. Education World, for example, is a Web site offering educator resources for lesson planning, professional development, administration, technology integration, news regarding school issues, as well as an online marketplace.[203] Teachers are also using social networking sites like Ning to create ad hoc working groups that facilitate swapping stories, advice, ideas, and lesson plans, among many other things.

A number of Web-based programs are also geared largely toward professional development and administrative support for educators. Indiana University, for example, offers fully accredited coursework online, which covers a variety of topics suited for elementary and secondary curricula.[204] Such professional development opportunities may allow educators to conveniently and cost-effectively continue their education.

- **Complete Administrative Tasks**

Educators are also using the Internet to complete certain administrative tasks and to deliver instruction. In 2008, approximately 99 percent of K-12 educators reported using computers and nearly 95 percent reported using the Internet in school at some point over the prior year.[205] The vast majority also reported using the Internet to provide data for teacher planning and "to provide assessment results and data for teachers to use to individualize instruction."[206] The portion of K-12 educators that use such technologies for administrative tasks on a daily basis is similarly high (76 percent).[207]

Teachers are also utilizing technology daily to communicate with other educators, post course information online for students, and communicate with parents through email.[208] However, less than half used technology for instruction-related activities.[209] Less than half of educators used technology daily to monitor student progress, for research and information, to instruct students, and to plan and prepare instruction.[210]

> ***"I have 3 computers in my classroom and 20 students, so it's hard for all of my students to get computer time. I use a projector with my computer to show Web sites for science and social studies. My school has a portable "laptop lab" and I use that once a week. I love using that because all of my students are on the computers at the same time. I use a Web site called "Third Grade Skills" - it has numerous games to help reinforce skills (math and reading) that I teach each week. My kids love it!"***
>
> ~ Rosemarie, 3rd Grade Teacher, Georgia

- **Leverage Web 2.0 Tools**

An increasingly popular use of broadband by educators is accessing the vast array of Web 2.0 tools for educational purposes. According to a recent study by the Consortium of School Networking (CoSN), "nearly three-quarters of [survey] respondents (superintendents and curriculum directors) said that Web 2.0 technologies had been a positive or highly positive force in students' communication skills and the quality of their schoolwork."[211] A majority of educators surveyed by CoSN agreed that "Web 2.0 has value for teaching and learning" and that these tools have "positive or highly positive impact[s] on students' interest in school, interests outside of school, self-direction in learning… and homework habits."[212] However, concerns abound regarding the safety and effectiveness of these tools in educational settings. These are discussed more fully in section 6.

- **Barriers to More Robust Utilization by Educators**

Though increasing numbers of educators are integrating technology into their classrooms, many remain reluctant to utilize new educational technologies and to adjust their teaching methods in response to technological advances. To illustrate, one study found that 57 percent of faculty members who teach in "smart" classrooms (i.e., classrooms outfitted with advanced information and communications technologies) fail to use the technology on a daily basis.[213] Moreover, even though most students state that technology is an important aspect of learning, only 33 percent of faculty members report that technology is fully integrated into the education experience.[214] Several barriers to more robust adoption and utilization of broadband by educators explain this relatively low rate of usage.

Lack of training. The low level of technology usage in the classroom is due largely to a lack of relevant training for educators. In 2005, 83 percent of public schools with Internet access reported that their school or district trained teachers on how to integrate Internet technologies into the curriculum.[215] However, 34 percent of schools offering professional development had less than 25 percent of teachers attend the professional development courses within the previous year.[216] Moreover, a 2008 report found that, even when technology training is provided by school districts, educators believe that their training is more effective for administrative tasks, leaving them unprepared for instructional use.[217] Thus, a lack of proper educator training may be discouraging further adoption and integration of broadband-enabled technologies and tools in the classroom.

Lack of technical support. Technical support may also be in short supply, especially within schools in poorer areas. According to one study, 70 percent of educators report having sufficient technical assistance for technology use in their school, and just 67 percent report adequate help for troubleshooting or fixing problems with school technology.[218] However, a 2008 study found that educators in urban schools are more likely to report poor working conditions of school computers and less technical support to help with repairs.[219] Innovative approaches to addressing these problems have been developed in recent years (see section 4), but until they are deployed at scale, many teachers will likely be unprepared to tackle technical issues raised by broadband use at school.

Lack of supportive software. Many teachers also lack access to supportive software, which can help address questions or problems as they arise.[220] Studies have found that software tools designed specifically for educator needs "enhanced the motivation of teachers to use computers and promoted the emergence of innovative teaching practices."[221] However, throughout the education industry as a whole, "little effort has been invested to promote the maturity of educational software products, especially software designed to fulfill the instructional requirements of teachers."[222] Moreover, many federal funding programs, such as E-rate, do not provide for the software used in lesson planning, preparation, and individual instruction.[223]

Organizational barriers. Some experts claim that a number of organizational barriers are hindering further usage of broadband-enabled tools and services, such as online learning programs in the classroom.[224] While there is much support for a new "culture of learning,"[225] acceptance of technology-centered education remains a concern among many educators.[226] Cultural factors impacting broadband usage by educators include "beliefs about the nature of teaching and learning, recognition and awareness of their role as teachers based on this philosophy, and a perception of the vision that technology may produce as they engage in instruction or promote learning."[227] In addition, teachers may be "accustomed to teaching within the traditional education model and are simply satisfied with the status quo."[228]

In an effort to help educators overcome these barriers, several efforts by public and private stakeholders are focused on increasing access to technical training and support, while also emphasizing the many benefits of incorporating such tools into instruction. Some have suggested further funding of research to highlight the proven benefits of technology in education and promotes the sharing of best practices,[229] while others have suggested the need for a national public engagement effort to increase awareness of broadband-enabled tools among both public and private stakeholders.[230] These and other recommendations are discussed further in section 6.

3.2.2.2 Impacts on Educators

Broadband impacts educators in a variety of ways. For example, broadband-enabled applications are increasing both the efficiency and the quality of instruction. Teachers benefit from the variety of professional development and informative resources available online and transfer such skills into the classroom. Indeed, teacher effectiveness can be enhanced though a number of tools, such as school-based forum discussions and video libraries of best practices.[231] One study from 2006 found that an online teacher certification program prepared teachers just as successfully as traditional programs and was able to attract more diverse candidates.[232] The program was also more successful in recruiting math and science teachers.[233]

Moreover, a number of Web sites aid teachers in the creation of lesson plans and foster a culture of shared knowledge and expertise. Through such tools, professional development can become an institutional priority and be applied regularly throughout the entire year.[234] With teacher effectiveness increasingly tied to student achievement, such tools are likely to improve learning outcomes and foster the development of 21st century skills.[235]

However, one potentially negative impact of broadband-enabled innovation on educators is the speed with which these tools can change. Indeed, one recent study observed that few schools or educators are adequately trained to keep up with rapid changes in technology.[236] Such a rapid pace of change could undermine current attempts to train educators to use the current crop of tools and thus further entrench the shared skepticism of so many teachers vis-à-vis using new technologies in the classroom. However, training the next generation of educators to use broadband and broadband-enabled technologies by default, and providing all stakeholders with technical support and expertise in a more consistent manner, could help to overcome these and many other barriers to more robust adoption of broadband by educators (see sections 4 and 6).

3.2.3 Broadband and Higher Education

Higher education institutions are incorporating broadband-enabled technologies into educational models in a number of innovative ways and oftentimes at a more rapid pace than other educational institutions. These approaches are having a number of positive impacts and are redefining how post-secondary education is delivered and consumed in the United States. Snapshot #4 provides a brief overview.

SNAPSHOT #4
Uses & Impacts of Broadband in Higher Education

Uses	Impacts
▪ Research by students & educators ▪ Use in educational administration ▪ Planning & administrative tasks ▪ Online learning ▪ Mobile learning	▪ Changes in the Institutional roles of universities ▪ Creation of competitive online universities

3.2.3.1 Usage in Higher Education

Colleges in the United States have long been a locus of cutting-edge research, innovation, and utilization of new technologies.[237] For example, some of the earliest telemedicine experiments – i.e., using communications technologies to deliver healthcare services over long distances – were conducted on university campuses.[238] Similarly, the Internet was developed and used as a research tool on college campuses beginning in the 1960s.[239] As discussed below, this tradition continues with broadband.

- **Student Use**

In general, college students are using the Internet frequently and for a wide range of activities. Ninety-eight percent of undergraduate students currently own a computer, the vast majority of which are laptops that are one-year-old or less.[240] About 95 percent of undergraduate students use the Internet to access university library Web sites, and 83 percent of students report having downloaded music or videos online via their school Internet connection, with 11 percent doing so daily.[241] Content production is also a popular activity among college students. Around 45 percent of students report contributing to video Web sites, 42 percent to wikis, and about 37 percent to blogs.[242] In addition, about 38 percent of students use the Internet to make phone calls (e.g., via Skype).[243] Social networking sites are also increasingly popular, with about 96 percent of 18-24 year old students having used social networking Web sites.[244]

- **Administrative Uses**

Administrators are using broadband to deliver a variety of tools and services for use by students and educators. For example, course management platforms are widely used for the creation of online learning environments and facilitating the administration of education processes. Between 2000 and 2008, the percentage of college courses that utilized Course Management Software (CMS) or Learning Management Software (LMS) increased from about 15 percent to over 53 percent.[245] Blackboard, a top competitor in the CMS/LMS market, offers a Web-based course-management platform geared toward higher education. The platform can be used for full or partial course delivery, content management, community engagement, as well as outcomes assessment.[246] Blackboard recently introduced a mobile platform that is available on mobile devices such as the iPhone, iPod Touch, and BlackBerry.[247]

- **Open Content**

Access to educational information in higher education is also being enhanced through the provision of open content on the Web. For example, the MIT Open Courseware (OCW) initiative, launched in 2001,[248] offers open access to hundreds of undergraduate and graduate-level materials and modules, many of which are translated into over 220 languages.[249] A survey of educators using OCW found that 23 percent use the site to learn new teaching methods, while 20 percent download content to use in their own courses.[250] Moreover, M.I.T. has found that a diverse audience is accessing their open courses. Indeed, "just 9 percent of those who use M.I.T. [OCW] are educators. Forty-two percent are students enrolled at other institutions, while another 43 percent are independent learners."[251]

Hundreds of other institutions have followed MIT's example and now provide open access to educational resources.[252] Yale University, for example, currently provides free access to a selection of introductory lessons through Open Yale Courses (http://oyc.yale.edu). The project expands access to educational material for interested learners and provides lectures in video, audio, and text transcript formats.[253] Carnegie Mellon University has launched an Open Learning Initiative in order to help beginning college students through virtual simulations, labs, and tutorials that provide continuous feedback.[254] Through the initiative, Carnegie Mellon found that "blending" online learning with in-person instruction "can dramatically reduce the time required to learn a subject while greatly increasing course completion rates."[255] In addition, many universities around the world are utilizing online platforms provided by companies like Apple to offer lectures online. To this end, more than 350,000 individual classes are available through iTunes from 800 colleges and universities;[256] downloads of these offerings recently surpassed the 300 million mark.[257]

- **Online Learning**

Broadband is also being used in higher education to enable online learning, which has been embraced by students, educators, and administrators alike. More than one in four higher education students "now take at least one online course," a figure that increased 17 percent between 2007 and 2008.[258] It has been estimated that 12.2 million students have enrolled in college-level credit-granting distance education courses, and of these enrollments, 77 percent were reported online courses, 12 percent in hybrid/blended enrollments, and 10 percent were reported in other types of distance education courses.[259] Internet-based technologies were cited as the most widely used distance-learning technology.[260] Examples of online learning in higher education settings vary widely and range from Harvard University's Extension schools, a continuing education program,[261] to New York Law School's Online Mental Disability Program (see Case Study #3).[262]

CASE STUDY #3

New York Law School's Online Mental Disability Law Program

Long a pioneer in adapting classroom learning to suit the unique needs of a diverse student body, New York Law School has launched a first-in-kind Web-based clinic that offers a variety of courses on mental disability law. The Online Mental Disability Law Program currently offers twelve semester-long courses that provide "the most up-to-date information and interpretation of the civil, criminal, and constitutional law regarding the rights of persons with mental disabilities." This program is the only online program focused on mental disability law that has been accredited by the American Bar Association.

Courses are often delivered via streaming video and are supplemented with reading assignments, online chats, and blog postings. In addition, live-streamed seminars are held several times during the semester in order to "connect in person with program faculty in order to best integrate the course material learned through the recordings, readings, blogs, and chat rooms." Additional information is available at the law school's Web site: www.nyls.edu.

- **Mobile Learning**

Broadband has also spurred an upward trend in mobile learning across many higher education institutions. Indeed, over half of undergraduate students own an Internet-capable handheld device, and an additional 12 percent plan to own one in the next year.[263] Undergraduates use their devices to access email, student administrative services, and course or learning management systems.[264]

A number of pilot programs and other efforts are underway across the nation to study the use of handheld devices for various teaching and learning purposes in higher educational settings.[265] Abilene Christian University in Texas, for example, just ended the first year of a pilot program that equipped 1,000 freshman students with either a free iPhone or iPod Touch. The devices were used for a wide array of activities, including "[W]eb apps to turn in homework, looking up campus maps, watching lecture podcasts, and checking class schedules and grades."[266] The University also experimented with using these devices to enable classroom participation, including "polling software for Abilene students to digitally raise their hand [in class]."[267] By the end of the year, 48 percent of the student body was provided a free iPhone, and 97 percent of the faculty was using iPhones as well.[268] Several institutions, including Oklahoma State University, are experimenting with iPads as supplements to or replacements of hard-copy textbooks.[269] These follow several programs at other schools that experimented with e-readers like the Kindle.[270]

3.2.3.2 Impacts in Higher Education

Increased adoption and utilization of broadband and broadband-enabled technologies are having two major impacts on higher education in the United States. *First*, as an increasingly large amount of course content migrates online, the institutional role is being shifted away from the university being a supplier of educational content and toward the university being a provider of an overall learning experience. The traditional educational experience includes "student support, tutoring and mentoring, teaching and learning, and the quality of the assessment."[271] Traditional notions of higher education are rooted in perceptions of the "academy as a place" that drew together the best minds and best resources to spur creativity and learning.[272] However, the movement toward open content and online courses is likely to reshape this traditional paradigm, even though virtual approaches to education do employ similar notions of education, teaching, and learning.[273] As open access to software, course content, textbooks, and instructors increases, and as research begins to substantiate this new approach as effective for certain students and learning purposes,[274] the overriding impact is a slow shift in the educational paradigm upon which the modern university has been built.

Second, widespread availability and adoption of broadband has spurred the development of alternative institutions for higher education. One of the leading examples has been the University of Phoenix, which launched its "online campus" in 1989 and is currently the largest private university in the United States.[275] The decreasing costs associated with providing degree programs online, which has resulted in an array of affordable programs for students, has spurred a robust marketplace for online university degrees and has further shifted the traditional higher education paradigm.[276]

3.2.4 Broadband and the Administration of Education

Snapshot #5 provides an overview of the myriad ways in which broadband is used by administrators and how this technology impacts administrative processes in educational settings across the continuum.

SNAPSHOT #5
Uses & Impacts of Broadband for Administrative Purposes

Uses	Impacts
▪ Streamline back office functions ▪ Outsource data processes ▪ Aggregate, store, and analyze student data	▪ Enhanced efficiency in completing tasks ▪ Cost savings by moving to cloud computing ▪ More collaboration

Broadband is used for a number of cost-saving and efficiency-generating administrative purposes within educational institutions at every level. For example, data systems are increasingly being utilized to improve the monitoring and management of student progress and achievement.[277] Indeed, at least 31 states currently employ student databases to track academic progress, a substantial increase from just a few years ago.[278] Many student tracking tools rely on broadband connections to safely store and reliably deliver this information. Through open source management tools, forum discussions, database evaluations, and collaborative online documents, teachers, and administrators are gaining a more dynamic view of student learning. Such tools allow student performance to be tracked over time and in comparison with statewide and international standards.[279]

Broadband is also being used to facilitate the aggregation, storage, and analysis of student-generated data. Programs such as ARIS, which is being used in New York City, "provide educators with a consolidated view of student learning-related data and tools to collaborate and share knowledge about how to accelerate student learning."[280] These tools allow educators to closely track student progress and make test results, along with attendance and other student-specific data, available to parents via an online portal.[281]

Broadband also allows for more widespread use of cloud computing services that streamline various information technology processes. Cloud computing has been defined as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."[282] These tools help institutions save money by allowing them to pay on an as-needed basis for software, platforms, and infrastructure delivered as services over the Internet.[283] By one measure, these products can cost 10 to 13 percent less than licensed commercial products with equivalent capabilities when considering the total cost of ownership.[284] Services provided via the "cloud" can include e-mail, data set storage, course management systems, help-desk, and licensed software distribution.[285]

The use of these types of resources is increasing in American universities, as nearly 60 percent of campus IT officials believe that they will play an increasingly critical role in future plans.[286] Further, 40 percent claim that their campus is currently testing such tools for use in central IT services[287] and the majority of these institutions reported utilizing Google and Microsoft for student e-mail.[288] Other large corporations, like IBM, are also aggressively pursuing large universities as potential customers of their suite of open source and cloud computing services.[289] Such uses have two core impacts on education administration.

First, broadband-enabled administrative tools provide schools an array of lower-cost options for pursuing certain IT projects. The recent economic downturn will play a significant role in determining future developments for educational technology. Budgets have already been cut back significantly, likely impacting future IT funding streams and projects for years to come.[290] As a result, plans for IT investment have been reconsidered and redrawn to focus on opportunities with assured outcomes of increased efficiency and lower costs.[291] Consequently, the near future is likely to witness increased growth in administrative IT, open source efforts, cloud computing, and online learning opportunities to efficiently and cost-effectively improve the delivery of education.

Second, utilizing broadband facilitates administrative and operational efficiencies. As IT projects are being reevaluated, new, more focused projects are being put forward to create efficiencies in specific administrative and operational processes. For example, the reporting capabilities of student tracking systems are being improved upon, data warehouses are being utilized to streamline reporting, and standard imaging solutions are being installed to facilitate office workflows.[292] Such solutions are being deployed in order to "produce cost savings or help units increase productivity to cope with the layoffs that have already occurred."[293] Many organizations are likely to begin sourcing such activities externally in open-source collaborations.[294] Collaboration among educational institutions and IT providers to streamline the provision of administrative services "is both an economic necessity and a driver for real innovation."[295]

Through the use of cloud computing, for example, "[e]fficiencies may be realized in aggregating personnel, expertise, licensing, business continuity, and other benefits far beyond the simply joining of computer hardware."[296] The aggregation of services such as server hosting, technical support, data storage, and e-mail to achieve economies of scale will provide significant cost benefits as multiple organizations leverage their resources to provide and share IT resources.[297] Efficiencies will also be enabled through the on-demand or as-needed provision of IT services through the cloud.[298]

3.2.5 Broadband and Adult Education

Adult professionals and corporations use broadband in a number of ways in an effort to enhance the number and diversity of available learning opportunities and to bolster outcomes. Snapshot #6 provides an overview of these uses and impacts.

SNAPSHOT #6
Uses & Impacts of Broadband for Adult Education

Uses	Impacts
▪ Continuing education for adults ▪ Corporate training ▪ Collaboration regardless of geography	▪ Anytime, anywhere learning ▪ Cost savings

Older learners utilize broadband to enable a variety of continuing education and job training opportunities. For example, online learning programs offer opportunities for professionals to further their education – whether for job training or continuing education – in a flexible, self-paced format that can be easily incorporated into their lifestyles. According to the National Center for Education Statistics, 39 percent of college students are adults over the age of 25.[299] As online degrees have become more commonplace, many employers now view such opportunities as a viable alternative to traditional education. Indeed, *"85 percent of employers representing a variety of industries across the U.S. feel that online degrees are more acceptable today than they were five years ago."*[300]

The proliferation of high-speed broadband networks has also enabled significant developments in online learning for use by corporations over the past several years. Indeed, a survey of several large corporations and organizations found that "technology was used to deliver 37 percent of formal training in 2005, up from 24 percent in 2003."[301] Another report estimated that "e-learning made up [nearly one-third] of all learning hours in the private sector in 2007."[302] IBM, for example, provides instructor-led online training through its IBM Training program. More specifically, the program offers "a comprehensive portfolio of technical training and education services designed for individuals, companies, and public organizations to acquire, maintain, and optimize their IT skills."[303]

Online learning reduces the costs to corporations and individuals, improves the effectiveness of training, and increases access to adult education. Indeed, Blackboard claims that "[b]roadband and high-speed internet access are critical elements in making online education accessible and affordable for learners. Online education, training, certification and re-skilling are more affordable than traditional education and impacts income."[304] *IBM found that its e-learning program "enables managers to learn five times as much material at one-third the cost of a classroom-only approach."[305] Through online learning, IBM claims to have saved $579 million in two years.*[306]

The cost savings realized from online training programs have helped some companies offset spending decreases on traditional professional development program. Indeed, while spending on corporate learning initiatives has decreased significantly, the number of online programs has increased.[307] As a result, a growing number of corporations are leveraging the popularity of social networking tools and using them as in-house research, collaboration, and learning tools for employees across the world.[308]

3.3 Conclusions

The preceding analysis supports a number of conclusions regarding how broadband is being used by and impacting students, educators, and administrators across the continuum. These include:

- Students, particularly younger ones, are avid technology users and are embracing broadband-enabled technologies to enhance their in-classroom education via online tutors, games, research, etc.
- A growing number of educators are using broadband-enabled tools to enhance their curricula, to augment classroom instruction, to engage students in learning outside of the classroom, and to participate in a variety of online professional development opportunities.
- A number of barriers exist to more robust adoption and utilization of broadband by educators and schools. These include a lack of technical training and support for incorporating these tools into curricula, negative perceptions regarding the value of using broadband in the classroom, and a variety of cost issues associated with purchasing the necessary equipment and bandwidth necessary to provide a full broadband experience.
- Higher education institutions have proven adept at leveraging high-speed broadband networks to provide coursework and resources and to manage classes through online learning environments.

- Online learning is a significant trend in K-12 schools, higher education, and private-sector professional development. Online learning decreases the costs of education, increases access to such opportunities regardless of geographic location, and enhances the effectiveness of instruction.
- An emerging trend in both K-12 and higher education involves the use of mobile devices to deliver educational content and participate in learning environments. Such tools erase the traditional borders of the classroom and facilitate more engaging interactions with learning material from any location at any time.
- Broadband-enabled tools are increasingly being used to create efficiencies and cost-savings in the administration of education across all levels.

4. The Role of Broadband in U.S. Education: A Survey of Recent Approaches

Broadband enables a multitude of applications and educational tools that are helping to reshape the education paradigm in the United States. Students are being more fully engaged in the classroom and at home via laptop initiatives, broadband connections, and new content. Broadband-enabled teaching and learning is occurring in a variety of contexts and is improving learning outcomes.[309] However, the many benefits and positive impacts of using digital technologies and broadband for educational purposes will not be fully realized without widespread adoption of broadband and computers – especially at home – and the effective integration of these tools into classrooms and other learning environments.

For those schools, teachers, and parents that remain wary or uncertain of the true value of using broadband to deliver and enhance education, numerous efforts are currently underway at every level of education to demonstrate the myriad benefits of using broadband-enabled education technologies. This section provides an overview of innovative public and private sector efforts focused on using broadband to enhance education for:

- Pre-K to 12th grade students, parents, and educators;
- Post-secondary students and educators; and
- Adult learners.

4.1 Approaches in Pre-K to High School

This section highlights an array of unique approaches at the local, state, and national level for integrating broadband into schools and using broadband-enabled tools to engage students and parents and to enhance teaching skills.

4.1.1 State & Local "Macro" Approaches to Increasing Broadband Utilization in Public Schools

To enable the far-reaching and myriad impacts of broadband in educational settings from pre-K to 12th grade, many state and local governments are working with schools and private organizations to provide access to, and necessary equipment for using, broadband and broadband-enabled technologies. These efforts often leverage statewide broadband networks and other such resources for use by individual schools.

A number of states operate large broadband networks that support a variety of educational and public institutions. For example, the Alabama Research & Education Network provides Internet access to K-12 schools, libraries, and post-secondary schools.[310] Many participating institutions receive free broadband access because of a special "legislative appropriations from the Alabama Education Trust Fund."[311] Similarly, a coalition of K-12 schools, state and local governments, the legislature, local businesses, and universities in Arizona have joined together under the auspices of the Arizona State Public Information Network (ASPIN) to ensure access to computers and the Internet.[312] Among other things, the program provides funding and information for educational programs that promote utilization of computers and broadband. One recent project of ASPIN, called Wireless Connectivity in Mohave County, provided one year of partial support to establish wireless connections in four K-12 schools in a rural Arizona community.[313]

Another program, based in California, has also partnered with stakeholders in the private-sector to promote broadband usage in schools. The Corporation for Educational Network Initiatives in California (CENIC) "designs, implements, and operates the California Research and Education Network (CalREN), a high-bandwidth, high-capacity network designed to meet the needs of California education and research communities at [K-12 and higher] educational institutions."[314] CENIC and CalREN were at the center of recent proposals by the California Broadband Task Force to leverage existing infrastructure and expertise to bring connectivity to as many schools as possible across the state.[315] Similar programs are currently in operation across the nation. They represent a critical source of funding and support for broadband access in schools.[316]

Through such networks, comprehensive online learning communities are being created and made available for use in both primary and secondary schools. Such communities include full online course programs as well as tutoring and other resources. OneCommunity's OneClassroom program, which is based in Ohio, provides an example of a comprehensive online education program serving K-12 students. According to OneCommunity, the program "is a secure, Web-based learning environment serving Northeast Ohio Counties, which delivers educational programs, technologies, and distance learning to Pre-K-12 schools to motivate students, improve educational outcomes, and increase the adoption of technology while reducing its overall cost of ownership."[317] Among other things, OneCommunity provides users with access to a "Digital Resource Library that allows students and teachers to quickly find and view state-approved content, including educational videos and other rich digital media from local and national providers."[318]

Similarly, Arizona-based IDEAL (www.ideal.azed.gov) is a comprehensive e-learning platform managed by the Arizona Department of Education and Arizona State University. Like OneClassroom, IDEAL provides educational resources for students across the state. A wide array of Web-based resources is available to help students complete homework assignments, learn new information, and prepare for their future. In addition, parental involvement is encouraged through IDEAL: Home Edition, which provides parents with information, resources, tips, and support strategies.[319] Finally, substantial content on IDEAL, however, is geared toward providing educators with resources and information regarding "professional development, standards-based curriculum resources, collaborative tools, and school improvement resources."[320]

While such efforts are focused on enhancing student achievement, teacher performance, and parental oversight via increased broadband use across entire states and across pre-K through high school, many programs are being developed at a more targeted level. The following sections explore specific efforts in a variety of contexts, including: pre-K through elementary school; middle school and high school; professional development for educators; and resources that encourage increased parental involvement in their children's education.

4.1.2 Pre-K and Elementary School

It is axiomatic that educational skills garnered at an early age are a key indicator of future academic success for students.[321] The incorporation of digital technologies into educational models for pre-K to fifth grade students is thus critical to ensuring the mastery of traditional content, as well as nurturing the development of 21st century skills. Educators, policymakers, and innovators in the private sector are deploying targeted content, tools, and approaches that use broadband to offer educational activities, information, and games to young children from preschool through fifth grade. In addition, stakeholders are increasingly integrating digital literacy requirements into school standards in order to ensure that the next generation of workers is able to compete in a rapidly globalizing knowledge-based economy.[322] This section provides an overview of some of the tools and approaches currently in use.

- **Online Content for Young Learners**

Many Web sites provide educational information and activities for younger students, such as those created by the Sesame Workshop. For example, Sesame's Panwapa (www.panwapa.com) offers a virtual community that fosters global citizenship and a broader international perspective among young students. The Web site allows children to "travel" safely around the world, learn cultural and geographical highlights about the places visited, watch interactive movies, and learn words in other languages.[323] The site has gained international recognition and, as of December 2010, had drawn over 314,000 young users to the site.[324] In addition, Sesame Workshop recently introduced free podcasts that feature Muppet characters teaching language and reading skills to young children.[325] These tools provide "anywhere, anytime learning" for young children.[326]

Children's books are also available online. For example, the International Children's Digital Library (http://en.childrenslibrary.org) "holds the world's largest and most diverse collection of digitized children's books freely available online."[327] The library includes thousands of stories from 60 different countries that can be read in either the story's native language or in English. Moreover, the entire collection is available on iPhones and iPods through a free app available at Apple's App Store.[328] Newer devices like the iPad are spurring the digitization and creation of a wider variety of children's books. Custom-made stories and books for smaller devices like the iPhone are being bolstered for use on larger-format devices (e.g., the iPad), allowing for more interaction and engagement by younger readers.[329]

Video-sharing Web sites are also increasingly popular among children. Indeed, Kaiser's recent study of media consumption habits of children aged 8 to 18 concluded that the "story of media in young people's lives today is primarily a story of technology facilitating increased consumption. The mobile and online media revolutions have arrived in the lives – and the pockets – of American youth."[330] A variety of video providers are adapting to these new consumption patterns. For example, PorchLight Entertainment recently introduced Kid Videos, a YouTube-inspired Web site that allows children to upload and view videos, send them to friends, and comment on them.[331]

- **Leveraging Mobile Devices**

In this increasingly mobile world, integrating broadband-enabled mobile devices into the educational context is critical in order to leverage the ubiquity and popularity of these technologies among both students and parents. To this end, a number of pilot programs have been launched to evaluate the efficacy and value of using mobile devices in the education of young students. The GeoHistorian Project, for example, is investigating "mobile phones as educational tools inside and outside the classroom" in order to "reduce barriers between schools and community resources such as zoos and museums, and above all, [provide] students the opportunity to create digital resources for their community."[332] In other words, broadband-enabled mobile technologies with built-in GPS, wireless Internet access, and Internet-based media-sharing sites are being used to connect classrooms with local historical landmarks in order to encourage "students to become video historians, creating and sharing a living history of real people and real places."[333] A pilot program in Florida, which provided pre-K through fifth graders with Palm Pilots, found that students successfully utilized the handheld devices to enhance the educational experience by, among other things, accessing the GoKnow Handheld Learning Environment. This allowed students to "use software tools that integrate word processing, concept mapping, drawing, animation, and the downloading of Web pages."[334]

- **Broadband in Pre-Kindergarten**

A variety of schools and private companies are leveraging broadband to enhance early education. IBM's KidSmart Early Learning Program, for example, "integrates new interactive teaching and learning activities using the latest technology into the pre-Kindergarten curricula."[335] Since being launched in 1998, over $106 million has been invested by IBM, building 45,000 KidSmart Early Learning Centers in 60 countries. An evaluation of the program found that participating teachers "grew significantly more adept at integrating technology into their instruction. The evaluation also found that children's comfort levels using computers increased significantly, with 99 percent of the children either comfortable or very comfortable with computers."[336]

Another pre-K-focused effort is the Georgia Pre-K Program, administered by Bright from the Start, which has served over one million students. To manage the development of so many students, Georgia's Pre-K Program uses the Work Sampling System (System), an observational student assessment system developed by Pearson, a global provider of education technology. The System is a "curriculum-embedded, teacher-guided, observational assessment in which multiple sources of documentation are gathered over time. The System involves the child, family, teacher, and program in the ongoing process of assessment and reporting."[337] The System also offers an online version, which helps educators to "efficiently and accurately gather and manage data."[338]

- **Broadband in Elementary School**

Elementary schools across the country are also experimenting with using technology inside and outside of the classroom for an array of purposes. For example, North

Elementary School in Noblesville, Indiana has launched a Virtual Library Media Center.[339] This Web site provides targeted math and literacy resources for students in Kindergarten through fourth grade, along with general resources for art, physical education, and music classes. In addition, the Virtual Library Media Center makes available social media tools like wikis, collaborative planning resources like Moodle, and a variety of databases for use by students, parents, and teachers.

Several schools in New York City are also using broadband and broadband-enabled technologies to enhance the educational experience. See Case Study #4 for an overview of these approaches.[340]

CASE STUDY#4

Innovative Elementary Schools in New York City

The New York City school district is the largest and most diverse in the country. Across more than 1,600 schools, the city's Department of Education oversees 1.1 million students and 80,000 teachers. With an annual budget of over $20 billion and a mayoral mandate supportive of innovation in how education is structured and delivered, New York City is a laboratory for experimenting with using technology to enhance learning outcomes.

Several elementary schools in the city are using broadband-enabled technologies to enhance curricula and further engage students. The Verrazano School (PS 101), located in Brooklyn, has expanded its 1:1 laptop initiative to 13 classrooms (from three) and leverages technology to engage students in maintaining the schools Web site and participating more actively in class by soliciting real-time feedback to guide teachers. According to Principal Gregg Korrol, "we must teach our students what we know they need to learn, in the context of the world in which they live." To do so, teachers administer Web-based literacy and math assessments to determine skill levels; access free online content via Teacher Tube to supplement in-classroom lessons; and reinforce lessons with podcasts and blogs. Parents are also encouraged to stay engaged via email and text messages. These technologies have had discernible impacts on learning outcomes for those students in tech-enhanced classrooms.

At PS 5 in the South Bronx, students use the One Laptop per Child XO computing model to develop 21st century skills. Fourth-grade students, for example, are tasked with writing online memoirs, while some third-graders use blogs to share poetry. Students use specialized literacy software to hone reading and writing skills. Teachers use a variety of online tools to "create individual student learning profiles to help them customize instructional activities." Parents are encouraged to access school-related materials online via a home computer or via the school's computer lab. The impacts of this approach have been similarly positive in terms of student engagement and student achievement.

4.1.3 Middle and High School

Broadband is also being used in a variety of ways to enhance education in middle schools and high schools across the country. This section provides an overview of some of these efforts.

- **Curricular Resources for Educators**

Several noteworthy efforts focused on curriculum enhancement and student tutoring provide enhanced learning opportunities both inside and outside of the classroom. Carnegie Learning (www.carnegielearning.com), for example, provides an array of curriculum resources for high school math teachers and students. Among its many offerings, Carnegie provides Blended Learning Math Curricula, which "integrate interactive software, text, and collaborative classroom activities for core, full-year math instruction."[341] Carnegie also offers a variety of math software solutions and customizable tutoring services. All of the organization's offerings are supported by professional development services in order to ensure that these tools are effectively used. Carnegie Learning has partnered with numerous school systems across the nation to deploy its services. In one instance, the Louisiana Department of Education provided students with access to Carnegie's Algebra Solutions. The participating students had higher performance outcomes than the control group of non-participating students. In another instance, a software pilot program in mathematics, funded by the Kentucky state legislature, found that all 12 participating schools "went from needing improvement to meeting [performance standards]."[342]

- **Digital Textbooks**

Increased access to and ownership of computers, particularly via 1:1 laptop initiatives (see section 2.2.1) and new pilot initiatives (discussed below), could eventually replace hard-copy student textbooks with digital versions that "can be downloaded, projected and printed, and can range from simple text to a Web-based curriculum embedded with multimedia and links to Internet content."[343] Digital versions of existing textbooks are increasingly available for purchase, while a growing number of titles are available free online. Though digital textbooks currently make up just 5 percent of the $7 billion U.S. textbook market,[344] they are gaining in popularity in many schools across the country. Indeed, California has put forward the largest effort in the United States to date through its approval of ten free math and science works for use in high schools. California Governor Arnold Schwarzenegger expects his digital textbook initiative to significantly cut the costs of education in the state and update instructional subject matter.[345] For the 2010-11 school year, California has launched an pilot program that will use iPads to replace algebra textbooks for 400 eighth-grade students.[346] The primary goal behind this initiative is to "prove the advantages of interactive digital technologies over traditional teaching methods."[347] In general, however, several barriers are impeding more robust growth of this fledgling market (see section 6.7 for further discussion).

- **Experimenting with Mobile Learning**

A number of pilot programs are examining the efficacy of using broadband-enabled mobile devices for middle school and high school education. Project K-Nect, for example, is a pilot program that has partnered with the North Carolina Department of Public Instruction, Digital Millennial Consulting, and a number of other organizations to deliver educational material to ninth-grade students in North Carolina.[348] The program "is designed to address three core needs that include the lack of at-home Internet Access for our country's poorest families, 21st century skills development, and the math and science skills deficit."[349] According to its project director, "75 percent of classes [using these devices] outperformed other cohorts in math subjects in the recently completed first phase of research. Students also displayed "increases in average study time" and "significant gains in parental involvement" were also reported.[350]

In Arizona, a school district is experimenting with making Wi-Fi available on school buses. The "Internet Bus" experiment allows students to access the Internet on their way to school and on their way home.[351] In addition to helping students more efficiently manage their time, this experiment has resulted in a drastic drop in bus-related behavioral problems.[352]

Abilene Christian University (ACU) in Texas has launched an initiative aimed at providing rural teachers with access to new technologies in the hope that these teachers will bring these tools and lessons back to their schools. To this end, ACU has developed a three-week summer session for middle- and high-school teachers that provide educators with an iPad and instruction in how to effectively integrate it into their curricula.[353] In an effort to lure teachers to this program, ACU offers participants the chance to earn professional development credits.[354]

- **Innovative Middle Schools and High Schools**

Middle schools and high schools have emerged as leaders in experimenting with using broadband to deliver unique educational experiences and to empower students by providing more targeted content, tools, and services. For example, the Science Leadership Academy (SLA) in Philadelphia was launched in 2006 to "provide [students with] a rigorous, college-preparatory curriculum with a focus on science, technology, mathematics and entrepreneurship."[355] Students and teachers use a variety of broadband-enabled tools – including laptops via a 1:1 initiative – to complete inquiry-based learning modules and to participate in ongoing projects (e.g., students operate the school's technical help desk).[356] The unique model implemented by SLA has created a culture of innovation and experimentation among students and teachers, and has resulted in an entirely new approach to high school education.[357]

Similar efforts are underway in schools across the country. See Case Study #5 for three examples from New York City.[358]

CASE STUDY #5

Innovative Middle Schools & High Schools in New York City

In addition to a growing number of innovative elementary schools, New York City is also home to a large number of forward-looking middle schools and high schools. For example, IS 339, a middle school based in the Bronx, has become a model for using laptops, broadband, and an array of broadband-enabled technologies to enhance learning outcomes (it was recently profiled in the PBS documentary *Digital Nation*). IS 339 uses a variety of Google tools to track student information (via Google spreadsheets), facilitate better and more timely communications (via Gmail, Gchat, and Google-enabled blogs), and streamline the submission of assignments (via Google Docs). Teachers are also encouraged to use a variety of Web-based resources to supplement and enhance lesson plans and to tailor certain lessons to individual needs. As a result of these and other tech-based methods, test scores have risen across the school.

At the high school level, leveraging broadband-enabled technologies has been one component of a multi-pronged effort to increase graduation rates, which rose to over 60 percent in 2008 (from 46 percent in 2005). Brooklyn Technical High School, for example, was created by legislative mandate to provide students with an "environment for the research and development of innovative and interdisciplinary approaches in the areas of mathematics, science, engineering, computer science and the liberal arts." Over 4,600 students enrolled in this school have a number of opportunities to use a variety of broadband-enabled technologies and tools. Students are encouraged to pursue college credit by, among other things, participating in a distance learning partnership with the North Carolina School of Science and Mathematics. Teachers and administrators use a variety of broadband-enabled tools to enhance lessons and to closely track student progress and achievement.

New York City's iSchool was launched as a model tech-based high school that "blends innovative technology with project-based curriculum modules." Students participate in one module each semester (modules focus on real-world issues). Most modules incorporate "electronic media, such as podcasts, Web sites, Facebook pages, and videos, often created by the students themselves with the school's digital cameras." Several modules leverage broadband-enabled video conferencing to speak with subject-matter experts relevant to their coursework. Students also have the opportunity to participate in online courses, which allow for more individualized and independent learning experiences.

4.1.4 Professional Development

The willingness of educators to experiment with integrating broadband-enabled educational applications into curricula is essential. However, as discussed in section 3, many educators lack adequate training and access to technical assistance and professional development services to encourage such experimentation. To address this problem, a variety of innovative approaches have been developed.

Via the Internet, K-12 educators have access to a wealth of information and resources for using new technologies to improve teaching methods. Many Web sites provide curriculum, lesson planning, and social support for teachers of all grade levels. Education World, for example, offers resources for lesson planning, professional development, administration, technology integration, news regarding school issues, as well as an online marketplace.[359] Likewise, Internet4Classrooms provides help for educators on a wide range of subjects, including help for certain grade levels, technology tutorials, assessment assistance, and an online database of links for educators.[360] PBS also offers online resources for pre-K through 12th grade teachers.[361]

A number of Web-based programs also provide professional development and administrative support for educators. eTech Ohio, for example, "serves as a one-stop-shop for providing planning, support and information about grants, subsidies and professional development, as well as teaching, learning and technology integration."[362] The program also supplies resources for administrators and technology support staff.[363] Alabama offers educator support through the Alabama Best Practices Program, which has established a 21st Century Learners Wiki.[364] The wiki is part of a collaborative effort, enabled through funding from Microsoft, which provides access to information resources for educators.[365]

Teach for America (TFA), a national organization that trains and places teachers in schools across the country, uses broadband to provide its recruits with a variety of ongoing professional development resources. For example, TFA has launched an online portal – TFANet – that provides teachers with an interactive forum for exchanging ideas and finding "assessments, lesson plans, tips, and strategies [to ensure that] they're not constantly reinventing the wheel. [This resource] debuted in 2008 with 6,500 materials; [as of 2009], there are more than 20,000."[366] Recent innovations on this portal include the availability of online educational videos for its teachers.[367]

Onsite technical support and professional development resources are a critical component of reassuring and encouraging hesitant teachers to use technology in the classroom. Several approaches have been developed to overcome these barriers. For example, at the Goddard School in New York City, a full-time "technology facilitator" provides teachers with convenient solutions to any technical queries.[368] The school's principal has also developed a number of workshops to supplement these efforts and has outlined a clear agenda for using laptops and other educational technologies in the classroom. MOUSE, a nonprofit organization based in New York City, has developed another unique approach for providing technical support in schools (see Case Study #6).[369]

CASE STUDY #6
MOUSE

MOUSE (www.mouse.org) was launched in 1997 to bring Internet access to public schools across New York City. However, once most schools were wired, a need for technical support quickly emerged. MOUSE leveraged its existing apparatus and developed a training program for students to become onsite IT experts. These groups of students eventually evolved into MOUSE Squads, which were initially deployed in schools across New York City. These Squads represent a "cost-effective solution to the problem of inadequate levels of on-site support in schools and the need to serve the 21st century educational needs of students." Moreover, participation in these groups "broadens the learning and 'life opportunities' of youth by providing authentic hands-on experiences that build skills and the motivation to succeed in school and life."

This program has had discernible impacts on both students and schools. The vast majority of MOUSE Squad members – 89 percent – reported better schools attendance as a result of their participation. Moreover, 92 percent of MOUSE Squad members indicated that they were better prepared for college because of the program. A Fordham University study of MOUSE found that participating students had increased academic performance. A Citibank study found that "schools running the MOUSE program save an estimated $19,000 per year in technology support costs." As a result of its proven effectiveness, the model has been adopted by schools in Chicago and California. There are currently over 340 MOUSE Squads, involving more than 5,700 students.

4.1.5 Parental Engagement

Broadband and broadband-enabled technologies are increasingly being used to engage parents in the education of their children. *Studies have found that "the family and the home are both critical education institutions where children begin learning long before they start school, and where they spend much of their time after they start school."*[370] Indeed, literacy development begins and is sustained at home, and skills and lessons learned in school are reinforced by parents at home.[371] As such, ensuring that parents are actively engaged in their child's education is crucial to ensuring that knowledge is retained and that skills are further developed.

Comprehensive programs, such as Arizona's IDEAL (discussed above in section 4.1.1), provide a wide range of information for parents to foster understanding and oversight of their child's education. More focused efforts include coalitions of concerned parents and school-specific student monitoring systems. The Wisconsin Coalition of Virtual School Families, for example, "provides information and support for families who are interested in having their children educated in virtual schools and advocates for the interests of those families."[372] In addition, Edline is an online platform used by many schools to enhance course organization as well as parent-teacher communication.[373]

Through the service, parents are able to monitor student grades, school news, class news, assignments, attendance and calendars, and other relevant information.[374] This is similar to the ARIS program that New York City recently deployed (discussed above in section 3).

A variety of informational resources targeted at parents have also been developed in recent years. Many of the organizations that supply this information seek to help parents understand how their children might be using new technologies and provide interested parents with ratings and other materials to help guide them through the nearly infinite universe of online content. One of the leading organizations in this field is Common Sense Media (CSM) (www.commonsensemedia.org). CSM educates parents about how their children are using certain types of digital media (e.g., social networking sites) and how some of these tools may be impacting them. For example, CSM has developed targeted resources regarding sexting, cyberbullying, and Facebook etiquette for parents and their children.[375] In addition, CSM partners with schools to provide onsite parent-student workshops and other targeted resources.[376]

However, not all homes and parents are the same. Indeed, the percentage of two-parent households has decreased sharply over the last several decades. As a result, overburdened single parents are often left with little time to focus on their child's education.[377] Several other factors, including income disparities and lack of quality daycare programs, have resulted in many children being unprepared for school and many parents being disengaged from their child's educational development. In an effort to bridge these gaps and to engage both parents and students in an array of online learning activities, several unique approaches have been deployed to push computers, broadband, and learning into the home. Examples include Technology Goes Home (discussed in section 5.3) and Computers for Youth (see Case Study #7).[378] Several programs that received federal stimulus funding have used these approaches as models (these are discussed in more detail in sections 5 & 6).

CASE STUDY #7

Pushing Learning into the Home: Computers for Youth

Computers for Youth (CFY) (www.cfy.org), which was launched in 1998, focuses exclusively on bolstering the in-home learning environment of low-income middle school students. Via its Take IT Home program, CFY provides students and parents with hardware (i.e., a computer), pre-installed educational software, and, in some cases, subsidized broadband connections to create a home learning center that seeks to improve student learning outcomes, increase parental involvement in their child's education, and extend the reach of teachers into the home.

In order to sustain this program, CFY offers two unique services to parents and students. First, CFY regularly hosts Family Learning Workshops. Every participating family is required to attend a half-day workshop that provides a tutorial on the home learning center that they will take home with them at the end of the day. Additional programs are held on a regular basis. Second, CFY provides 24/7 bilingual technical support to answer any questions that participating families might have.

CFY works directly with educators and other personnel at partner schools to ensure that they are adequately trained to leverage these tools. To this end, CFY provides a number of professional development resources that help train teachers and parents to use technology to enhance the student learning experience.

Computers for Youth currently serve over 4,000 families each year in cities across the country. The impacts of this program have been impressive. Several analyses conducted by CFY have found that participating students report increased effort in class, more academic curiosity, and better performance. Nearly all participating parents – 90 percent – "felt more confident in helping their children learn as a result of CFY's program."

4.2 Approaches in Higher Education

Higher education institutions are incorporating broadband-enabled technologies into educational endeavors in innovative ways. Such efforts have led to the incorporation of a wide array of digital tools within the physical classroom to engage students and enhance instruction. Educational content is increasingly being provided online to increase access to high-quality instruction. Broadband-supported administrative tools are also frequently used in higher education settings to create efficiencies in the provision of educational services.

A number of online tools are available to assist in the integration of technology in postsecondary instruction. PLATO, for example, is an innovative educational technology company that provides "personalized instruction, technology-based teaching tools, and standards-driven assessment and data management."[379] A similar provider of higher education instructional tools is the Center for Computer-Assisted Legal Instruction (CALI), a non-profit consortium of law schools. CALI "researches and develops computer-mediated legal instruction and supports institutions and individuals using technology and distance learning in legal education."[380] Interactive lessons and educational materials on numerous law school subject areas are offered through the Web site in an interactive, question and answer format.[381]

More targeted efforts are being deployed in higher education classrooms to provide innovative educational experiences. For instance, a professor at the Indiana University School of Social Work has implemented a program through which virtual seminars are held with students in Second Life, a virtual world.[382] Students create avatars and interact with other students and the professor online. Another professor at Northeastern University in Boston lectures his students through streaming videos that remote students are able to view online.[383]

Twitter is also being applied as an educational tool by some professors. Live discussion threads are implemented during class lectures, which provide for the real-time sharing of feedback and information, as well as the gathering of useful data.[384] This type of tool also allows professors to acquire some additional insight into how students are reacting to course material during the lecture.[385] Students may also be more motivated and able to participate in class discussions, as participation is no longer dependent on speaking out in front of the class and discussions can be extended beyond class-time.[386]

Broadband is also being used by educators to collaborate with colleagues and to share best practices. To this end, the Carnegie Foundation for the Advancement of Teaching recently launched an open version of its learning environment – the Teaching and Learning Commons – to facilitate the sharing of case studies regarding teaching and learning projects and to provide access to a number of Web-based tools used to create the case studies. The Commons allows educators at all levels and all locations to share experiences and participate in conversations regarding teaching practices.[387]

4.3 Adult Education

In addition to its impacts on students from pre-K through 12th grade and higher education, broadband is being used to enhance adult education and corporate professional development. To this end, numerous companies are using broadband to expand their corporate training services. In addition, as a result of increasing utilization of Web-based tools and services by corporations, several organizations are now specializing in the delivery of these tools. As such, a large number of companies are devoted to delivering employee training services over the Internet. Though there has been a decrease in overall spending on professional online learning programs over the last few years, broadband continues to facilitate efficiencies, cost savings, and increased access to corporate professional development programs.

A leading company in the delivery of such content is Enspire Learning. Enspire "creates learning experiences that address strategic business and training challenges."[388] It provides custom e-learning development applications that drive employee retention and change behavior, as well as simulations and game-based learning, and custom learning solutions that address business issues in areas such as finance, leadership development and business process improvement.[389]

Such professional development tools are being used to increase the accessibility and efficiency of employee training. Quiznos, for example, trains its employees via its Corporate University, which consists of a nine-month blended learning curriculum. The University offers a number of educational materials via an online platform, including required lessons and tutorials as well as online operations manuals.[390] The program also utilizes the Quiznos Sub Commander Game, which remotely trains its many franchise members to, among other things, make sandwiches.[391]

Similar approaches to online training are also being developed and adopted abroad. The Kenya Nurse Upgrading Program, for example, uses e-learning to educate and train Kenyan nurses. In 2005, the program began "with a pilot of four schools and 145 students and aims to upgrade 22,000 Enrolled Community Health Nurses from 'enrolled' to 'registered' within 5 years."[392] This program utilizes e-learning to deliver the training "due to its interactivity, cost effectiveness, ease of revision and ability to achieve the goal in less time and at a lower cost than the residential" program.[393] To date, this program has increased the number of registered nurses in Kenya.[394]

4.4 Conclusions

The many innovative efforts being implemented across the continuum of education – from preschool through high school and college and into the corporate world – has spurred a vibrantly innovative educational technology industry. Moreover, educators and parents are increasingly aware of the fact that, with their students and children spending more time online, the best and more effective ways of engaging and stimulating them exist in those virtual spaces. As a result, an increasing amount of educational content is migrating online, and new technologies are being deployed to facilitate access and the delivery of these tools and applications. Broadband is thus an essential and versatile vehicle that provides many of these tools with a reliable and fast medium through which they can be made widely available to students across the nation and around the world. As discussed in the next section, broadband will continue to play a major role in shifting the education paradigm and transforming the ways in which education is delivered and consumed.

5. THE IMPACT OF GREATER BROADBAND AVAILABILITY & TECHNOLOGICAL ADVANCES ON EDUCATION

Greater broadband availability and continued technological innovation at the network level and across the education sector will impact students, parents, and educators in profound ways in both the near-term and long-term. This section provides an overview of innovations at the broadband network level and assesses how innovators, educators, parents, students, and other stakeholders will leverage these advanced networks to deploy cutting-edge educational content.

5.1 Innovation at the Broadband Network Level

Many of the innovations in educational technology described in previous sections rely on advanced broadband networks to deliver content, tools, and services. Future advances in the transmission of educational content will, in both the near- and long-terms, increasingly depend on more robust broadband connections to assure timely and reliable delivery of time-sensitive data and content to educators, parents, and students. As such, innovation at the network level will ensure that educational technologies are widely available and reliably delivered.

Despite the recent economic downturn, broadband network owners continue to invest billions of dollars each year to bolster their infrastructure and to reach new customers. Indeed, network owners invested some $30 billion in broadband networks in 2009, representing about half of their capital expenditures.[395] Many expect that, in the absence regulatory uncertainty, service providers will continue to invest similarly large sums of money in their networks over the next several years.[396]

However, as discussed in section 3.1.1, pockets of the country remain unserved. In order to reach these areas, the federal government has funded two grant programs dedicated to spurring broadband availability in unserved and under-served regions of the country. The goal of these programs – the Broadband Technology Opportunities Program (BTOP), administered by the National Telecommunications & Information Administration at the U.S. Department of Commerce,[397] and the Broadband Initiative Program, administered by the Rural Utilities Service at the U.S. Department of Agriculture[398] – is to fund broadband infrastructure deployments to unserved parts of the country and to support programs that seek to sustain broadband adoption and make computers more widely available.[399]

In addition to these targeted efforts, network owners continue to deploy new infrastructure and update existing networks.[400] For example, companies like AT&T[401] and Verizon[402] are bolstering their networks by deploying wide-scale fiber-optic lines to increase the speed of data transmissions. In addition, cable companies are deploying a new network standard – DOCSIS 3.0 – that will enhance transmission speeds over existing infrastructure.[403] Comcast and other cable companies have already deployed this new standard in many areas across the country and expect to make higher network speeds available to all customers in the near future.[404]

Wireless broadband is poised to become a critical platform for enabling a variety of innovations in the education arena and many other sectors.[405] By 2010, 82 percent of American adults owned a cellphone.[406] According to the FCC, by mid-2009, "35 million mobile wireless service subscribers had mobile devices (such as laptops and smartphones) with data plans for full Internet access, as compared to 25 million six months earlier."[407] Most importantly in the educational context, the number of children with basic cellphones and advanced smartphones is rapidly increasing. Indeed, Kaiser has found that cellphone ownership rates among children between the ages of 8 and 18 increased from 30 percent in 2004 to 66 percent in 2009.[408] Among teens, three-quarters owned a cellphone in 2009.[409] Texting remains the most popular cellphone-based activity among this group by far (66 percent of teens with cellphones report sending and receiving texts), but using handsets to access the Internet is growing in popularity (over a quarter of teens with cellphones use them to go online).[410]

As a result of an overall shift towards a preference for more robust mobile content in the education sector and beyond, carriers are investing heavily in the deployment of advanced networks. In the near term, third- and fourth-generation (3G and 4G) networks will continue to be deployed by wireless carriers. While 3G networks are already available to a significant portion of the population,[411] 4G networks will be deployed by wireless carriers in the near future to provide faster and more reliable service.[412] Since more robust connectivity – via advanced networks and cutting-edge devices – will beget more demand for mobile data services, widely deployed and carefully managed wireless networks are essential to supporting the growing number of mobile devices that are being used for educational purposes.[413]

5.2 Near-Term Outlook

As a result of increased availability and utilization of broadband and broadband-enabled educational technologies, the traditional education paradigm is undergoing a significant shift. As discussed above in sections 3 and 4, broadband-enabled tools are transforming traditional approaches to teaching and redefining educational institutions across the continuum. In the near-term, several important trends are evident.

First, access to and adoption of broadband and other technologies will increase as a result of a renewed focus on educational reform and innovation at the federal and state level. Several federal and state-led programs are providing critical funding and support for the development of innovative educational technology programs in schools across the nation. Moreover, private-sector efforts and public-private partnerships are playing an integral role in expanding access to technology and facilitating skill development for all students, particularly those from low-income homes. These programs provide funding and necessary support for accessing these tools and will also facilitate the integration of broadband and broadband-enabled technologies into a variety of learning environments.

The federal Race to the Top program is a leading example of an innovative approach to spurring technology integration in the near-term. This program, which is administered by the U.S. Department of Education, allocated $4 billion in 2010 to spur reform in schools across the country.[414] In particular, this program rewarded and supported states that implemented forward-looking reforms "by using college- and career-ready standards and assessments, building a workforce of highly effective educators, creating educational data systems to support student achievement, and turning around their lowest-performing schools."[415] Ultimately, Race to the Top rewarded those states with the most innovative approaches to reform. A key aspect of reform, especially as it pertains to developing 21st century skills, is technology integration, specifically broadband utilization inside and outside of the classroom. While Race to the Top is not focused exclusively on technology or broadband, some commentators have noted that the program could indirectly spur technology use.[416]

A key impact of the Race for the Top program has been the high number of states that have made commitments to wide-scale, comprehensive reform.[417] Indeed, nearly every state in the country "joined a nationwide partnership to develop a common set of rigorous, career-ready standards in reading and math."[418] For example, numerous states, including Illinois, Louisiana, New York, Tennessee, and California enacted laws or policies allowing the expansion of charter schools.[419] Many other states implemented changes to how they monitor and reward teacher performance.[420] Such efforts are likely to have significant indirect impacts on the number of innovative technology programs in operation across the nation.

In addition, magnet and charter schools will likely be key laboratories for experimentation and innovation in how technology is used to enhance the educational experience. Several studies have found that charter schools "are more likely than public schools to adopt promising practices such as use of technology in the classroom, new staff development programs, involvement of teachers in policymaking, pre-K programs, and parent contracts designed to boost parental involvement."[421] Moreover magnet schools, which provide specialized curricula on discrete topics, are also fostering innovation and developing best practices that could be exported to other public schools. For example, Florida's Lee County School District operates the Academy for Technology Excellence, a technology-focused magnet school that seeks to "prepare high school students to excel in a society built on information and technology."[422] The program was developed in 2005 by educators searching for more innovative methods to prepare students for a technology-based society.[423] The program has witnessed overwhelming success as test scores have risen above state and district averages, and graduation rates also increased.[424] As a result of these successes, Lee County is now considering expansion of the program to other district middle and high schools.[425]

Other innovative approaches are seeking to not only develop school technology programs, but to *incorporate technology into the daily lives of students and their families.* Many such programs focus on bridging the digital divide between low-income students and their peers to adequately prepare them for 21st century careers. The Boston Digital Bridge Foundation, for example, operates the Technology Goes Home (TGH) program, which trains underprivileged families to effectively use technology.[426] Through the Boston Public School system, TGH brings together students, parents, and teachers in order to educate them on the use of technology and foster parental involvement.[427] The program has enjoyed support from teachers and administrators as it "improves student academic performance, changes the dynamic between parents and teachers, and it improves parental involvement with their children and the schools."[428] In particular, TGH engages parents and students in research projects, which are used as a way to teach and hone critical literacy skills for children and workforce skills for adults.[429]

A similar approach that seeks to foster parental involvement and technology integration in the home is a proposed pilot program by the National Cable and Telecommunications Association. Its Adoption Plus (A+) program is a two-year, public-private partnership seeking to support sustainable broadband adoption and impact educational outcomes by providing discounted home computers and broadband connections for up to 3.5 million low-income middle school-aged students in school districts across the United States. [430] In addition, the program would provide digital literacy training through school districts for both students and their parents, thereby addressing the multifaceted barriers to student broadband adoption.[431] Program partners would include federal and state governments, non-profit corporations supporting digital literacy, hardware and software manufacturers, and broadband service providers (see section 6 for additional discussion). [432]

These and many other innovative programs are being supported in various ways by both public and private stakeholders. If continued, this rate of investment and collaboration could lead to significant increases in student access to and utilization of broadband and broadband-enabled technologies and improved learning outcomes in the years to come.

The second trend evident in the near-term is that increased use of online learning will have wide and profound impacts on students, parents, and educators. As discussed above, online learning is expected to grow significantly over the next few years, impacting not only the availability of educational content but also the quality of education. *While over 2 million students in pre-K-12 are currently learning online, this number is expected to jump to* *over 10 million students by 2014.*[433] According to Ambient Insight, "the number of students taking all of their courses in physical classrooms will drop to 40.5 million, while 3.8 million will take all of their classes online, and 6.7 million will take some of their classes online."[434] Growth is also expected in online certifications in the near-term.[435]

The recession has not hindered the demand for online learning and course management products, and may actually have increased the need for such time- and cost-saving tools.[436] Indeed, utilization of technologies such as course management systems, video streaming, online testing, and exam tools, as well as online learning libraries, are expected to increase over the next several years. Course management systems, in particular, are likely to play a critical role and evolve into interactive learning environments, rather than simply providing "management" support.[437] Research also predicts a rise of blended learning instruction in coming years, which combines online instruction with face-to-face offerings.[438]

As online learning becomes more widely utilized and accepted, the quality of online education and learning outcomes are also expected to improve and may even surpass that of traditional instruction by as early as 2013.[439] Such tools are expected to enable a shift toward more learner-centered teaching techniques, utilizing collaborative, problem-based learning tools, rather than traditional lecturing.[440] As a result of this shift, students will likely be better equipped for competing in a 21st century workforce.

The third trend evident in the near-term is that the rise in social learning, currently evident in higher education, will begin to trickle down and be used more ubiquitously across many grade levels. Experimentation with Web 2.0 tools such as blogs, wikis, videoconferencing, and podcasting is on the rise in higher education institutions and in many K-12 schools.[441] These tools hold enormous potential for dramatically reshaping the traditional educational paradigm.[442] However, outdated policies have slowed the utilization of these tools for educational uses, particularly in the K-12 schools.[443] In the near-term, as student use of these tools increases outside of school (e.g., at home or on handheld devices), schools will likely begin to revise their policies to reflect student usage patterns and support the development of social learning opportunities.

Web 2.0 tools are being integrated and used in educational settings by innovative programs in higher education and are poised to deliver significant impacts on traditional approaches to instruction. Indeed, some commentators claim that "[t]he most profound impact of the Internet, an impact that has yet to be fully realized, is its ability to support and expand the various aspects of social learning."[444] Social learning, enabled through Web 2.0 tools like blogs and wikis, allows students of all ages to garner understanding through conversations and interactions with other individuals and with the material being studied.[445] Indeed, CoSN has found that "Web 2.0 tools can provide highly interactive and participatory environments that establish communities, open a myriad of communication channels, and ensure each individual and group a voice. In fact, there is a growing body of evidence that the collaboration inherent in the participatory nature of Web 2.0 tools can be leveraged to deepen student learning through authentic, real-world learning."[446] Moreover, a report issued by the MacArthur Foundation in 2008 observed that, through broadband networking and online relationships, "youth engaged in peer-based, self-directed learning online" and that youth are often "more motivated to learn from peers than from adults."[447] In addition, the report claims that, "to stay relevant in the 21st century, education institutions need to keep pace with the rapid changes introduced by digital media."[448]

To this end, Web 2.0 tools are currently being used in higher education settings and are "empowering learning in ways that hadn't been possible before."[449] Electronic portfolios, wikis, podcasts, and collaboration tools are being employed by educators to give students a more active role in the learning process. As previously discussed, professors are using Twitter to enhance instruction,[450] while students use Twitter for group projects and to communicate with one another and with the professor to discuss various issues.[451] In addition, virtual worlds are being used by many higher education institutions to offer interactive, engaging and alternative learning environments. As utilization of these types of tools increases, they will likely begin to be used more often in K-12 settings as well.[452]

However, even though educators appreciate and largely understand the value of social learning tools, administrators and educators at the K-12 level have been slow to adopt these tools.[453] Indeed, the majority of district administrators, superintendents and curriculum directors report that Web 2.0 tools have yet to be incorporated into teaching and learning in their districts.[454] This low level of adoption is due partly to outdated policies and practices regarding new technologies. Educators are working to balance the need for safety and protection from inappropriate material with the many benefits that are likely to be realized from using these tools.[455] To this end, one recent survey found that over 53 percent of district administrators believe that Web 2.0 "has caused [their] district policymakers to become nervous about allowing student access to it."[456] In addition, another recent survey found that more than one in five students between the ages of 10 and 18 reported being cyberbullied at least once in their life.[457]

New policies are evolving to facilitate increased use of these tools in K-12 settings. Many current policies are restrictive of certain Web 2.0 applications and have failed to address the new opportunities that such tools have made available. For example, most districts allow prescribed educational use of Web 2.0 technologies, though social networking and chat room participation are banned in the vast majority of school districts.[458] In addition, over 94 percent of technology directors require students and/or parents to sign an acceptable use policy before using the Internet at school, though 51 percent of district administrators claim that their policies have not been updated to address the use of Web 2.0.[459]

Internet filtering systems also impede the use of some Web 2.0 tools in many schools. Twenty-one percent of curriculum and technology directors reported that educators ask that ports be opened to allow the use of educational sites "fairly often" and 62 percent report that such requests are made "occasionally."[460] In addition, schools that receive funding from the federal E-rate program are subject to the Internet filtering requirements set forth in the Children's Internet Protection Act of 2000.[461] Discussions are currently underway in the majority of school districts to address the potential use and misuse of Web 2.0 tools.[462] Moreover, district administrators have expressed support for the use of such technologies in the future, as 61 percent of district administrators believe that access to approved educational sites should be allowed in school.[463] In the near term, addressing these types of novel policy issues will likely become inevitable as student use of social media and as educator support for them continue to grow. As policies adapt to the unique situations and issues raised by such technologies, social media is likely to be widely incorporated into K-12 educational settings over the next few years.

5.3 Long-Term Outlook

Enhanced connectivity to and utilization of broadband and broadband-enabled education technologies in the near-term will facilitate a number of fundamental shifts in the educational paradigm in the long term.

First, wireless broadband will become a key medium for the delivery of targeted educational content. Wireless broadband is already prevalent on college campuses and a number of K-12 schools. One survey from 2009 found that 88 percent of school districts and 96 percent of higher education institutions currently offer wireless networks, and 65 percent of schools without a wireless network are considering installation within the next few years.[464] To take advantage of developments in wireless networking, laptops and other mobile computing devices are becoming more mainstream in higher education and are increasingly being used in K-12 settings as well. According to one report, about 79 percent of college freshmen own a laptop computer that is relatively new and about 51 percent of all college undergraduates own an Internet-capable handheld device.[465] Moreover, 44 percent of undergraduate respondents expect to use their mobile devices for many activities they currently perform on a laptop or desktop computer, and about 74 percent of those who use the Internet from their handheld device expect their usage to increase in the next few years.[466] Kaiser has found that laptop ownership rates from children aged 8 to 18 more than doubled over the last few years, increasing from 12 percent in 2004 to 29 percent in 2009.[467]

Competition in the wireless and laptop markets are driving prices down and providing a wide array of innovative new products. Indeed, even though cellphones have traditionally been much cheaper than laptops, the new generation of more advanced smartphones and smaller, more portable laptops – also called netbooks – has brought the price points of each technology more in line. The popularity of each type of device has exploded in recent years and offer intriguing new mediums for engaging students.[468] Moreover, the Apple iPad represents the next iteration in the rapid innovation currently evident in the portable computing device market. The iPad supports 3G network access and could eventually be used as platform for delivering an array of educational content[469] and for facilitating a variety of activities.[470] Competition across the many segments of the wireless ecosystem – which includes wireless service, hardware, software and "apps" – will continue to drive costs down and spur use of these tools in an array of educational settings.

The major impact of more robust adoption and utilization of mobile broadband devices will be a major shift toward "anytime, anywhere" learning. This trend is increasingly evident in higher education and may trickle down to K-12 environments in the long-term. Moreover, the "potential of mobile computing is being demonstrated in hundreds of projects at higher education institutions."[471] For example, the University of Washington provides free Wi-Fi on campus, which is accessed by over 15,000 handheld devices in a typical month. The university "maximizes learning on the go with its iTunes U site and custom app – m.UW – [which is] available for free in the App Store. The m.UW app gives iPhone users a searchable directory, course information, campus news and events, and more than a thousand video lectures."[472] These types of programs will likely produce best practices that will be imported for use in an increasing number of K-12 settings in the longer term.

Second, as technology adoption and digital literacy skills diffuse across greater percentages of the population, there will be greater opportunities for more individualized learning experiences. Technology-enabled personalized learning holds significant implications for the future of education. Indeed, the Department of Education, in 2008, noted that "[p]ersonalized instructional delivery through the strategic use of technology is a key part of [educational] transformation."[473] By utilizing technology to adapt instruction to the needs of individual students, educators are better able to engage students, foster motivation, and enhance productivity.[474]

Educators have begun to apply technology to personalize learning in pre-K-12 and higher education settings, and will likely do so on a larger scale in the long-term. To this end, the federal Race to the Top program has called for the widespread adoption of data systems in school systems across the nation to manage student performance.[475] These systems track student achievement and preparedness for college[476] and "offer instructors the ability to view and interpret data on learner traits such as prior experience, knowledge, and learner style, and use that data to customize student experiences and their own instructional approaches."[477] In addition, learning management systems can work with data systems to automatically deliver personalized content.[478]

Other methods of personalization are also being used. For example, Advanced Academics provides "customizable online learning solutions that include Web-based curriculum, highly qualified teachers, a 24/7 support environment, and a proprietary technology platform specifically designed for middle and high school education."[479] Similarly, iClass is a new "intelligent cognitive-based open learning system and environment" being developed by 17 partners in the EU, Turkey, and Israel.[480] The project is based on the concept of self-regulated personalized learning and will give students an active role in the learning process. Moreover, "the Web-based iClass platform is well placed to link seamlessly the formal and informal learning environment."[481] It is designed to provide pupils with ubiquitous access in an effort to encourage them to maximize formal and informal learning opportunities.[482]

Third, higher education institutions will be redefined. As a result of the many advances and innovations described above, higher education has entered a time of uncertainty as traditional roles and identities are being reestablished for a technology-dependent future.[483] More specifically, the future is likely to bring the unbundling of higher education services and a greater focus on meeting the demands and needs of individual students.[484] Universities are currently unbundling some coursework and making it available in an array of forms via a number of outlets (e.g., podcasts, streaming video, open courseware, etc.). This wider offering of coursework increases the accessibility and affordability of such materials for students and allows institutions to reach a wider audience of students.[485] The long-term impacts of these trends will likely be greater demand for more flexibility in higher education as students increasingly desire to "determine for themselves which products, services, and information they are interested in using."[486] In the future, higher education curriculum and infrastructures may be designed to satisfy these diverse demands, thus undermining the historical role of higher education institutions.[487]

5.4 Conclusions

Ongoing innovations in educational technology, along with key innovations at the broadband network level, will have profound impacts on the traditional education paradigm. In the near future, public and private efforts will likely spur access to broadband and educational technologies and stir demand for online learning programs. Moreover, social learning will likely continue to become more prevalent in K-12 settings, enabling new, more engaging methods of instruction in most grade levels. In the long term, wireless broadband and advanced mobile devices will likely serve as primary vehicles for the delivery of educational content. This will expand access to "anywhere, anytime" learning. Moreover, these and other approaches will shift the education paradigm toward more personalized learning. Coupled with the migration and unbundling of vast amounts of educational content online, this shift will redefine the roles of education institutions across the continuum. As a result, students of all ages will become increasingly equipped to compete in the global economy.

6. Government, Education & Broadband: Recommendations for Meaningful Policymaking

In order to realize the full potential of broadband in education, policymakers must address a number of key issues. Recommendations for meaningful policymaking include:

1. Address cost issues related to adoption and usage of broadband for educational purposes through a combination of public-private partnerships, targeted funding, and reform of the federal E-rate program.
    - 1.1 Continue supporting public-private attempts that seek to address cost issues associated with adopting and promoting broadband use in school and at home.
    - 1.2 Improve the targeting of federal funding aimed at spurring broadband adoption in all of the nation's schools.
    - 1.3 Modernize the federal E-rate program.
2. Address the lack of computers in schools through support of public-private partnerships and other unique collaborations.
3. Develop and implement a multifaceted strategy for supporting the development and honing of 21st century digital literacy skills across the continuum of education.
4. Provide adequate professional development resources and support for educators in order to facilitate greater integration of technology into curricula.
5. Support efforts to identify and promulgate proven outcomes and best practices associated with using broadband-enabled technologies in schools in order to spur additional adoption in schools and at home.
6. Encourage ongoing collaborations among stakeholders that seek to spur adoption and utilization of broadband and broadband-enabled technologies for educational purposes.
7. Pursue a multifaceted approach to enhance online educational content.

8. Support the nation’s pro-investment policy framework for broadband in order to encourage continued innovation at the network level and across the educational technology sector.

* * * * *

6.1 RECOMMENDATION #1

Address cost issues related to adoption and usage of broadband for educational purposes through a combination of public-private partnerships, targeted funding, and reform of the federal E-rate program.

Despite the many efforts currently underway to increase broadband and technology utilization in education, cost issues have prevented many schools from adopting many of these services.[488] As a result, broadband adoption rates in schools and classrooms, on a national level, remain fragmented – and average per-student bandwidth remains low.[489] Compounding this, the recent economic downturn has forced many schools to delay or cancel education technology-related projects.[490] As IT budgets continue to be cut, schools must either find alternative means of funding projects, which can run as high as several hundreds of thousands of dollars, depending on the school’s location,[491] or forgo projects.

In addition to the institutional costs of deploying broadband-enabled education technology systems, students and their families also face significant financial constraints that are impeding more robust home adoption and usage of broadband for educational purposes.[492] Many online educational programs require a broadband connection, a computer, and other enabling technologies in order to complete Internet-based assignments. Though home broadband adoption has grown significantly in recent years, the adoption rate among low-income households and certain demographic groups still lag behind the general population.[493] Many low-income families are unable to afford a monthly broadband subscription, particularly when combined with the costs of purchasing a home computer and any additional educational software.

A number of negative impacts result from a lack of proper investment in school broadband connections. For example, schools with low per-student bandwidth rates are often forced to impose strict usage policies on students and educators alike. Indeed, one recent survey found that 67 percent of schools use a restriction policy that bars students and teachers from using certain online applications (e.g., streaming video) to conserve bandwidth.[494] Moreover, when broadband-enabled resources become limited or difficult to use, many teachers respond by reducing the amount of technology they incorporate into their lessons.[495] At home, students without a computer or an Internet connection are at risk of falling behind other students

Policymakers should address these various cost issues in three interrelated ways.

6.1.1 Continue supporting public-private attempts that seek to address cost issues associated with adopting and promoting broadband use in school and at home.

While federal funding support of state and local educational initiatives remains critical (see below), public-private partnerships offer a variety of advantages to more precisely target broadband adoption in schools and at home. These types of collaborations have succeeded in a number of other broadband contexts and efficiently pair public funding with private-sector expertise in developing and implementing innovative solutions.[496] Policymakers can leverage these approaches by providing ongoing support of innovative and forward-looking proposals.

To date, many public-private partnerships focused on spurring adoption and use of broadband in schools have succeeded because of some level of government involvement (several examples were discussed above in section 4.1.1). A unique illustration of the beneficial interplay of public and private sector resources is the South Carolina K-12 Technology Initiative, which is a partnership of the South Carolina Department of Education, South Carolina Educational Television, South Carolina Budget and Control Board, the South Carolina State Library, and AT&T. This partnership "guides the distribution of funds appropriated by the Governor and General Assembly that collectively meet the state's needs for software, hardware, connectivity, digital content, instructional technologies and professional development."[497] In the 1990s, South Carolina became one of the first states in the nation to wire all schools for the Internet and to adopt teacher and student technology curriculum standards.[498] However, the program is highly dependent upon state funding to cover the cost of maintaining school Internet connectivity, and recent decreases in funding have prevented schools from leveraging "critical programs that have proven value to learning and digital equity."[499] Additional federal funding could expand this pioneering approach to bringing technology to schools.

The initiative announced by the National Cable & Telecommunications Association in December 2009 – the A+ Program – is an example of a large-scale public-private initiative that could serve as a model for efforts going forward. The A+ Program aims to increase in-home broadband access and usage for low-income, middle school-age students.[500] The initiative is a proposed two-year, public-private partnership between participating school districts, federal and state government, nonprofit corporations focused on digital literacy, computer manufacturers, and broadband service providers. Federal funding and matching contributions by private-sector donors would be used to pursue a multifaceted approach, which includes "(1) digital media literacy education, including online safety training; (2) discounted desktop, laptop, or netbook computers that can access the Internet; and (3) discounted home broadband service to households that do not currently receive a broadband service."[501] A crucial aspect of this program is that it will draw up to $572 million from the cable industry,[502] in addition to federal, state, and school-based support. This represents one of the most comprehensive proposals for broadband stimulation to date and potentially one of the largest private allocations of funding for these purposes.

Some of these programs have received funding as part of federal broadband stimulus grant programs.[503] However, significantly more funding is needed to support additional and more expansive programs. Indeed, some have suggested that it would take approximately $10 billion in funding to ensure that all schools are "technology rich."[504] Thus, a more long-term and sustainable funding approach must also be considered in order to ensure that innovative approaches continue to be developed and deployed.

6.1.2 Improve the targeting of federal funding aimed at spurring broadband adoption in all of the nation's schools.

A number of federal funding resources are available to schools. Examples include:

- The EETT Program administered via Title II of the No Child Left Behind Act (discussed in section 3.1.2);
- Stimulus funding allocated via the U.S Department of Education and the Commerce Department's BTOP program (discussed in section 5.2);
- The Department of Education's Race to the Top program (discussed in section 5.2); and
- Federal E-rate program (discussed below).

Despite this seeming surfeit of funding, allocations are often imprecise and made in overlapping and redundant ways. For example, the $650 million allocated by the U.S. Department of Education for education technology can be used by states to "pay for things such as professional development to help teachers learn how technology can improve their lessons, software programs to enhance lesson plans, and computer labs."[505] However, federal stimulus funding will also be used to support computer labs.[506] In addition, some have argued that general stimulus disbursements for educational purposes might serve to prop up failing schools rather than create incentives to change by, among other things, effectively incorporating technologies (e.g., computers and the Internet) into the curriculum.[507] Such overlap and imprecision could result in waste and deter efforts to integrate broadband-enabled educational technologies into schools. This lack of coordination at the federal level suggests a lack of a comprehensive framework guiding these efforts.

Policymakers can address shortcomings in a number of ways. Government allocations should, for example, be more precisely targeted and less open-ended. The FCC acknowledged these issues in its *National Broadband Plan* and outlined several recommendations for reorienting the E-rate program.[508] In 2010, the Commission adopted several orders focused on modernizing and streamlining the program (these efforts are discussed in the next section). Moreover, the U.S. Department of Education, via its Race to the Top program, has doled out funding as a reward to states for implementing innovative changes to curricula and other efforts aimed at enhancing student performance by, among other things, effectively incorporating technology into curricula (see section 5.2 for further discussion).

In addition, the U.S. Department of Education, via its *National Educational Technology Plan*, has outlined a "vision for how information and communication technologies can help transform American education."[509] The plan focuses on using technology to enhance productivity, teaching, learning, and assessments. This Plan, which "provides a set of concrete goals that can inform state and local educational technology plans as well as inspire research, development, and innovation,"[510] is a promising step in the right direction and could serve as a jumping off point for additional discussions regarding how to more efficiently target funding to support the country's vision for a more innovative and effective education sector.

Another related consideration is ensuring that funding allocations are not unduly influenced by considerations other than actual need. For example, some have argued that current allocation mechanisms discriminate between geographic areas by prioritizing funding for rural areas.[511] Legislation introduced in 2009 – the Achievement Through Technology and Innovation (ATTAIN) Act – seeks to "ensure that every student is technologically literate by graduation, regardless of the student's race, ethnicity, gender, family income, geographic location, or disability."[512] The Act has been endorsed by a number of stakeholders who view it as an opportunity to "focus… resources on those practices known to best leverage technology for educational improvement."[513] Similar targeted funding efforts that provide support for school broadband and educational technology, regardless of geographic location or other ancillary considerations, should be encouraged at the federal level.

6.1.3 Modernize the federal E-rate program.

The E-rate program, administered by the Universal Service Administrative Company under the direction of the FCC, provides critical support to schools and libraries for telecommunications and Internet access.[514] Both public and private institutions are provided discounts of between 20 and 90 percent toward telecommunications services, Internet access, internal connections, and basic maintenance of those connections.[515] The program structure provides a funding priority for schools with high poverty levels and/or rural residence.[516] Over the past ten years, the program has provided over $22 billion to help schools and libraries pay telephone and Internet bills and install network wiring and components.[517] As a result of such largesse, "schools and districts have come to rely heavily on telecommunications networks to deliver educational content and to administer student achievement tests."[518] However, despite some success over the past decade, concerns abound regarding E-rate's funding structure, rural preference, and application process, all of which may limit its ability to meet the technology needs of educators. In order to ensure that this critical program is adequately structured for the broadband era, policymakers should consider a number of modifications.

First, the total amount of E-rate funding should be increased. Lack of adequate funding via E-rate is a much-cited barrier to further adoption and utilization of broadband in everyday education.[519] One major reason for this has been an inability to adjust E-rate funding levels for inflation or changes in demand over the past decade.[520] Indeed, funding levels have been capped at $2.25 billion[521] even though the amount of requested funding has consistently exceeded the allotted amount from 1998 to 2007.[522] In 2008, for example, nearly 40,000 applicants requested a total of $4.3 billion from E-rate.[523] The FCC, as part of its commitment to modernizing the overall Universal Service Fund (USF) and the E-rate component of it, has outlined a framework for adjusting the amount for inflation.[524] However, the total amount available to schools for broadband connectivity will remain essentially unchanged in the near-term.[525] Several other recent actions by the FCC could ensure that these limited funds have more impact,[526] but a limited pool of funding could thwart more sweeping changes necessary to bolster broadband in education. However, additional funding for broadband in schools and in homes with school-age children could be sourced from a reoriented USF, which the FCC hopes to transition to supporting broadband service, rather than traditional telephone service, over the next few years.[527]

Second, funding should be allocated to schools regardless of location. As currently structured, the E-rate program provides smaller awards to low-income schools not located in a rural area. Indeed, the discount rate is ten percentage points higher for rural schools than for urban schools with one percent to 49 percent of students eligible for the National School Lunch Program.[528] By limiting the priority given to rural schools, the E-Rate program can encourage low-income urban schools to apply for the funding they need. In its *National Broadband Plan,* the FCC outlined several recommendations for ensuring that funding is prioritized based on need and not on location.[529]

Third, the E-rate application and approval processes need to be streamlined. The complex application process for the E-rate program may serve to decrease the applicant pool.[530] Just 63 percent of the 150,000 eligible schools in the United States are currently taking part in the program, with 13 percent of eligible private schools applying for funding.[531] Nonparticipants state that the complexity of program requirements is a key barrier, though the process is becoming easier.[532] Between 35 to 50 percent of applicants are typically new to the E-rate process, and must devote large amounts of time and resources to receive funding.[533] Furthermore, funding has been denied to some participants in the past due to mistakes in the application process.[534]

In order to address these concerns, attempts have been made to make the application process more user-friendly.[535] A new format has been developed, which focuses on educating new applicants on the complex program procedures.[536] The FCC, in September 2010, adopted a series of new rules to simplify the current application process by, among other things, eliminating certain redundant requirements (e.g., technology plans) and providing more clarity regarding bidding criteria for applicants.[537] By simplifying and streamlining the E-rate application and approval processes, schools will be better able to "focus resources on providing funding for high-speed broadband connectivity [rather than] bureaucratic processes."[538]

6.2 RECOMMENDATION #2

Address the lack of computers in schools through support of public-private partnerships and other unique collaborations.

Although computer availability and ownership rates have steadily increased over the past decade, a significant number of students and schools remain without sufficient computer resources.[539] Indeed, a 2008 study found that over 50 percent of public school teachers reported having just two computers or less in the classroom or primary work area for students.[540] A number of viable approaches have been implemented in schools across the country to address this gap in computer access. Policymakers should support these and other innovative approaches to spurring computer access in schools.

One-to-one laptop programs, for example, should be encouraged. As discussed in section 2.2.1, many schools are working with private providers to deliver laptops to students for use during the school day and often to take home as well.[541] The impacts of these programs have been largely positive, so long as they are carefully designed and effectively implemented. However, despite the promise of 1:1 initiatives, they are often very expensive to launch and sustain. For example, in South Carolina, the legislature has set aside $5 million toward the iAm Laptop Pilot Program, which will provide ninth-graders in six public schools with laptop computers to keep for four years.[542] Moreover, a number of BTOP grant recipients include large-scale 1:1 laptop initiatives, including one by the New York City Department of Education for $28 million. This effort will provide low-income sixth graders in 100 schools across the city with laptops and subsidized broadband connections in order to "link…the classroom and the home to simultaneously support the achievement of disadvantaged students, while spurring broadband adoption."[543] Such programs are valuable because they have been shown to improve student performance. Additional federal mechanisms and other incentives should be developed to encourage continued collaborations focused on increasing computer access in both the near-term and long-term.

Other innovative approaches could also be held up as models for other schools and states to follow. For example, both Computers for Youth and Tech Goes Home (discussed above) provide valuable best practices that could be exported to schools across the country. Indeed, Computers for Youth has created a nationwide network of affiliates that "provides members with the products and services to more efficiently implement their programs while increasing the depth of services offered to their constituencies."[544] The network is currently comprised of 21 members in 16 states. A more systematic framework for leveraging effective approaches (e.g., by collecting and promulgating best practices), in addition to providing additional funding, could further spur computer access for students, parents, and educators across the country.

6.3 RECOMMENDATION #3

Develop and implement a multifaceted strategy for supporting the development of 21st century digital literacy skills across the continuum of education.

Educators, scholars, and policymakers agree that students must be equipped with digital literacy skills to succeed in a world dominated by digital media and information.[545] Indeed, as early as 1996, the U.S. Department of Education recognized that technology literacy "ha[d] become as fundamental to a person's ability to navigate through society as traditional skills like reading, writing, and arithmetic."[546] Over the last decade, as technology facilitated the development of a more globalized marketplace, the need for an appropriately skilled workforce has become more immediate. As discussed above in Snapshot #2, many new jobs "involve higher levels of knowledge and applied skills like expert thinking and complex communicating," along with the ability to effectively use broadband and broadband-enabled technologies.[547] Indeed, as the FCC has observed, "the demands of the new information-based economy require substantial chances to the existing [educational] system" in order to ensure that the United States is well positioned for continued economic prosperity.[548]

However, many stakeholders agree that a significant number of U.S. students do not possess these skills and are thus ill-equipped to compete in the global marketplace.[549] Moreover, there is some disagreement as to what 21st century digital literacy skills should encompass.[550] A 2009 report by the New Media Consortium found that "[i]ssues of assessment and integration of new literacies across the curriculum and of teacher training are complicated by the overarching need for a fuller understanding of what constitutes new literacy skills."[551] In addition, recent attempts to spur skill development on a national scale have mostly floundered. For example, the NCLB calls for all students to be technology literate by the end of the eighth grade, but provides no requirements or accountability measures to ensure literacy levels.[552] Even attempts by individual states have produced mixed results. While 48 states currently offer technology standards for students, only four states actually test the technology literacy skills of students.[553] The low level of technology literacy tests is due largely to the lack of widely accepted and measurable standards.[554] In light of the current status of 21st century skill development in the United States, policymakers should address these failings in a number of ways.

First, federal and state government should work together to establish digital literacy as a national priority by setting measurable standards. Although major curriculum changes typically flow from individual states,[555] benchmarks could be set through traditional methods of assessing student progress. The National Assessment of Educational Progress (NAEP) program, for example, is "the only nationally representative and continuing assessment of what America's students know and can do in various subject areas."[556] The NAEP criterion could be expanded to include measurable standards of technology literacy.

In the alternative, performance benchmarks tied to federal education funding could be revised to include technology requirements.[557] The NCLB IID competitive grants, for example, have called for "systematic changes in policies, practices, and professional learning that increase or enhance a school's ability to use technology effectively in teaching and learning."[558] Although some stakeholders warn against the implementation of formal requirements and standards, others argue that a piecemeal, state-by-state, and possibly district-by-district, approach might further delay integration of technology into school curricula.[559] One model could be the set of model educational standards released by state governors and educational officials in early 2010. These standards attempted to capture and formalize the range of skills every student in the United States ought to possess after completion of each grade.[560] Benchmarks for ensuring technology literacy were included in these standards.

Second, funding should be targeted at expanding programs and identifying best practices that have successfully promoted digital literacy. Innovative and successful approaches should serve as models for future programs aimed at enhancing digital literacy. For example, the University of South Carolina has developed the GameDesk pilot program, which "challenges 15- to 17-year-old pupils to create their own computer games using game tools, such as GameMaker, to build educational and entertainment video games from scratch."[561] Three high-priority high schools are participating in the study, and, through the program, students are expected to garner skills in math, science, and technology.[562] According to a 2009 report by New Media Consortium, such collaborative efforts between universities and K-12 teachers and students are invaluable and will likely become more popular so long as they are adequately funded.[563]

Another innovative approach has been deployed by One Economy, a national nonprofit organization, in partnership with Comcast. Their Digital Connectors program represents a unique approach to diffusing digital literacy skills across diverse populations by empowering capable and interested students with these skills. In particular, this program "identifies talented young people, immerses them in technology training, and helps them build their leadership and workplace skills to enter the 21st century economy."[564] By the end of 2011, the program is expected to reach some 1,500 students in 50 markets across the country.[565] These efforts will be further bolstered over the next few years by a federal BTOP grant[566] and have been used as a model for the FCC's proposed National Digital Literacy Corps.[567] This approach, which is similar to the model developed by MOUSE (discussed in Case Study #6), provides students with a vehicle for not only learning and applying digital literacy skills, but also with a viable post-graduation career path.

In sum, when devising a strategy for enhancing 21st century skill development in the United States, policymakers should be more comprehensive in their approach and should seek to engage innovators that are successfully training students to use new broadband-enabled technologies and tools.

6.4 RECOMMENDATION #4

Provide adequate professional development resources and support for educators in order to facilitate greater integration of technology into curricula.

As discussed in section 3, many educators have yet to integrate technology into their curricula. The reasons for this vary. Some educators are both unwilling and unable to incorporate technology into classroom curricula, even when adequate access is provided.[568] In addition, some are unaware of the many benefits of using technology to enhance learning inside and outside of the classroom, while others feel that technology will disturb the conventional roles of instruction.[569] Indeed, a significant number of teachers fear that traditional roles will be reversed if students have more familiarity with technology than their educators do.[570] Moreover, many educators that adhere to established teaching methods are "accustomed to teaching within the traditional education model and are [thus] simply satisfied with the status quo."[571] In addition, new tools like Web 2.0 services often befuddle educators and administrators, many of whom are unwilling or unable to rationalize the potentially negative aspects of these tools (e.g., cyberbullying) with the overwhelmingly positive impacts that these tools, properly leveraged, can have on learning.

Compounding these attitudinal barriers is a general lack of access to adequate professional development, technical support, and other resources that could assuage fears and encourage *educators to experiment with using new technologies in their teaching*. However, just making these resources available is not a panacea. In 34 percent of schools offering professional development courses, less than 25 percent of teachers attended the professional development courses within the previous year, according to one study.[572] Moreover, a 2008 report found that much of the technology training available to educators is geared toward administrative tasks, rather than preparing teachers for instructional use.[573] Throughout the education industry as a whole, "little effort has been invested to promote the maturity of educational software products, especially software designed to fulfill the instructional requirements of teachers."[574]

In order to overcome these barriers, policymakers and education administrators have a number of options available to them for enhancing the resources available to reluctant educators and for creating incentives for integrating broadband-enabled technologies into their curricula. For example, policymakers could create mechanisms that leverage existing approaches to providing teacher technology training and technical support. Examples of these efforts were described in section 4.1.4. These types of approaches rely on local resources and have proven to be successful in helping educators recognize the many benefits associated with using new educational technologies in their classrooms.

In addition, funding could be strategically allocated to encourage experimentation with supportive technologies in addition to, or perhaps in lieu of, more traditional onsite technical assistance. A growing number of supportive software tools are being developed to help teachers transition to the digital classroom. For example, the Adobe Digital School Collection "provides affordable multimedia software and resources for teaching and learning 21st century literacy, problem solving, and communication skills across the curriculum."[575] These tools help educators to edit documents, manage portfolios, edit video and audio content, as well as publish Web content. Moreover, the Collection includes a Teacher Resource DVD that provides lesson plans, tutorials, and educator tips.[576] A large number of other such tools and Web sites – e.g., Ning (www.ning.com), a customizable social networking site, Moodle (http://moodle.org), which helps teachers develop online courses, and an array of technology-specific blogs – are also available to educators as a kind of informal resource exchange. As previously mentioned, several large organizations, like Teach for America, have launched either proprietary or publicly-available resources for use by educators. These tools help educators learn and manage various educational applications and support technology integration on a wider scale. Some of these are free, but others require paid subscriptions or the purchase of proprietary software. The FCC has called upon the U.S. Department of Education to "provide additional grant funding to help schools train teachers in digital literacy."[577] This is a step in the right direction, but policymakers must do more in order to encourage wide-scale experimentation with using new technologies to enhance the educational experience across the continuum.[578]

6.5 RECOMMENDATION #5

Support efforts to identify and promulgate proven outcomes and best practices associated with using broadband-enabled technologies in schools in order to spur additional adoption in schools and at home.

A critical component of spurring adoption of broadband-enabled technologies for educational purposes is identifying and promulgating proven outcomes, benefits, and best practices associated with using these tools. Providing this information in a comprehensive yet user-friendly way could engage larger swaths of schools and parents and encourage them to experiment with new methods and applications.

However, the amount of information available to educators, parents, and students – from data on how certain technologies impact learning outcomes to statistics about technology usage to a vast array of studies examining digital literacy, social learning, etc. – *is intimidating and may be dissuading genuinely interested stakeholders from pursuing certain technology solutions.* Moreover, this information overload can result in uncertainty regarding the true impacts and effectiveness of using broadband-enabled technologies and tools.[579] Further, the seemingly constant emergence of new e-learning technologies and methods creates confusion for educators trying to determine which tools are best for their classrooms or schools.[580] Similar perceptional problems pester parents. For example, a study released by the Joan Ganz Cooney Center in 2008 found that a majority of parents do not think the Web helps their children learn how to communicate or work with others, or to be responsible in their communities.[581] Moreover, 59 percent of educators stated that parents underestimate the value of digital media.[582] These negative attitudes contradict research that consistently finds positive learning outcomes associated with educational technology[583] and blended learning approaches.[584]

In order to overcome this formidable barrier, policymakers and other stakeholders could pursue a number of approaches. *First and foremost is devising a systematic way of processing, cataloguing and highlighting important data sets, observations, and conclusions embedded in the vast array of studies, reports, white papers, etc. that are released each year by the U.S. Department of Education, its partners, third-party groups, and other interested stakeholders.* A more comprehensive approach to managing existing data and collecting more targeted information regarding student performance could help to rationalize some of the information overload.[585]

Second, state and federal government could sponsor more targeted research on discrete issues. For example, one issue that continues to puzzle educators and parents is the true value of using social media for educational purposes. A number of studies by an array of organizations have already been released on this subject, but very few are seen as truly authoritative (or as bearing the imprimatur of the U.S. Department of Education). Local, state, and federal government, either directly or through other entities, could sponsor official studies that either conduct original research or that compile a meta-analysis of existing studies.[586] There is a demand for these studies, the results of which could be widely disseminated and used as a basis for identifying best practices.[587]

One potential model for this type of undertaking could be an effort recently undertaken by the European Commission (EC). The EC called for a comprehensive analysis of approaches to teaching digital literacy as part of its i2010 strategy to foster greater inclusion and utility of information and communications technologies. The project and subsequent report, titled *Supporting Digital Literacy: Public Policies and Stakeholders' Initiatives*, examined 450 digital literacy initiatives in Europe, and highlighted 30 projects as best practices.[588] Among the many valuable lessons garnered from the analysis, the EC found that "it will be necessary to develop adequate criteria, evaluation methodologies and benchmarks that can be used effectively to target resources to those areas of need and to measure impact and value for money."[589]

The U.S. Department of Education has outlined a similar proposal for supporting and scaling, as appropriate, the development of new approaches focused on further integrating education technologies like broadband into the classroom.[590] In particular, this plan calls for a comprehensive aggregation and analysis of best practices for using new technologies not only in the educational context but also in the consumer and business contexts as well. Moreover, the Department of Education will spearhead higher-risk research and development projects in order to ensure that students and teachers have access to the widest possible range of new techniques for using these tools to enhance the learning experience.[591] If fully implemented, this plan could bolster the use of broadband-enabled technologies inside and outside of the classroom and thus ensure that students of all ages are properly equipped to compete in the global economy.

6.6 RECOMMENDATION #6

Encourage ongoing collaborations among stakeholders that seek to spur adoption and utilization of broadband and broadband-enabled technologies for educational purposes.

Recent efforts centered on increasing broadband adoption generally and broadband-enabled educational technologies specifically should be supported and encouraged to continue into the future. These efforts have included the U.S. Department of Education's various stimulus-funded grant programs (e.g., Race to the Top), which have been conducted in a relatively open and transparent manner, and the collaborative approach it implemented during the drafting and review of its *National Education*

Technology Plan, which actively solicited input from the community of educators, parents, and other interested stakeholders.[592] The FCC also employed an interactive approach during the development of its *National Broadband Plan*. For example, through its Broadband.gov Web site, the agency facilitated real-time communication and stakeholder involvement via, among other resources, a blog dedicated to the Plan.[593] In addition, the FCC hosted several collaborative workshops, the proceedings of which are archived online.[594] Through these efforts, the FCC "promote[d] open dialogue between the FCC and key constituents on matters important to the national broadband plan."[595] Policymakers and other stakeholders could leverage government interest in facilitating collaboration to launch a wider-scale initiative focused on spurring adoption and use of broadband in education.

In structuring a collaborative initiative, policymakers could set clear policy objectives and then defer to stakeholders to engage in solution-focused dialogues as to how to meet those goals. Such an approach, driven initially by a government entity, could nudge the diverse array of stakeholders in the education space towards more unified action on issues of overriding interest. *By encouraging conversations between policymakers, educators, parents, and even students, innovative solutions can be addressed and resources can be pulled to create the necessary change.*[596]

Once established, these types of collaborative efforts could partner with other programs and organizations that seek to raise public awareness of technology generally and broadband specifically. These organizations might include CoSN, MOUSE, Computers for Youth, and One Economy's Digital Connectors program. CoSN works to empower "K-12 school district technology leaders to use technology strategically to improve teaching and learning" and provides "the leadership, community and advocacy tools essential for the success of these leaders."[597] Similarly, One Economy's Digital Connectors program, MOUSE, and Computers for Youth could each provide a unique platform for engaging a wider array of stakeholders. These and other vehicles could be leveraged to support ongoing, wide-scale collaborations among stakeholders in the public and private sectors.

6.7 RECOMMENDATION #7

Pursue a multifaceted approach to enhance online educational content.

Despite the proliferation of online educational content over the past decade, many teachers and parents lack access to high quality educational information resources.[598] This is largely due to the difficulties associated with adapting or digitizing curriculum content for delivery via broadband, as well as the large up-front costs required to produce high-quality digital versions of existing educational content (e.g., textbooks).[599]

As such, policymakers and other stakeholders should pursue a multifaceted and comprehensive approach to enhancing the quality of online educational content.

For example, an output of the wide-scale collaborations discussed in section 6.6 could be a digital information clearinghouse that provides "ready-to-use and customizable [broadband]-based resources."[600] Such an effort could evaluate the quality and safety of educational content to encourage utilization of appropriate and effective the material in classrooms.[601] This approach could make it easier for educators to sift through the vast array of information online and more easily identify high-quality content. In doing so, collaborators could leverage the expertise of existing organizations in order to provide this information in more expeditiously. Organizations like Common Sense Media could be a partner in these efforts. Potential partners focused on offering relevant information about quality online content currently exist. The Federal Resources for Educational Excellence, for example, is an online database that provides teaching and learning resources from over thirty federal agencies.[602] The U.S. Department of Education also maintains an online library of education research and information through the Education Resources Information Center.[603] The FCC has also called upon several parts of the federal government to pursue new policies in order to "expand digital content and online learning systems."[604] *Coordinating these many efforts could yield a comprehensive clearinghouse that identifies useful resources from an array of public and private sources.*

In addition, quality online educational content could flow from a wider embrace of open course materials currently available on the Web. As previously discussed, numerous organizations and universities are now providing schools, educators, and individuals with free and open access to educational resources (e.g., MIT's Open Courseware). However, making available a comprehensive library of digital textbooks remains one of the primary goals of forward-looking educators.[605]

To date, the print textbook industry has begun to offer free versions of some materials online.[606] California became a leading state in the effort to push more textbook online when it announced its digital textbook initiative will not only reduce textbook costs, but will also provide for more current and relevant educational content.[607] New devices – like Apple's iPad or dedicated e-readers like Amazon's Kindle – could spur more rapid digitization of textbooks and could eventually create a new distribution model for the industry.[608] Indeed, several studies have argued that the unbundling of traditional education content could drive down costs for students and educators and provide access to only the content that these stakeholders need.[609] Distributing unbundled content is made much easier online and, in the textbook context, could be enhanced via the implementation of an iTunes model, whereby consumers would be able to download and use individual chapters rather than whole books. Having access to individual bits of textbooks online could cut costs on the demand-side and could encourage innovation in curriculum development across the continuum.[610] *Policymakers could consider devising incentives to nudge textbook producers in this direction.*[611]

6.8 RECOMMENDATION #8

Support the nation's pro-investment policy framework for broadband in order to encourage continued innovation at the network level and across the educational technology sector.

As discussed throughout this report, broadband has emerged as a vital medium for the delivery of a growing universe of educational content. Even though pockets of unserved areas remain, broadband is widely available and is being increasingly adopted in schools and homes across the country. The current regulatory approach to broadband and the ecosystem of services and applications that it has nurtured has been decidedly pro-investment and pro-competition in nature.[612] This approach has resulted in an enormous amount of innovation that is impacting education at all levels. But for robust broadband networks, cutting-edge educational tools and applications may not have been developed. Going forward, stakeholders across the education sector – including innovators of educational technology, educators, parents, and students – will increasingly rely on the wide availability of advanced broadband network infrastructure as the primary means of reliably delivering and consuming advanced content and services aimed at enhancing the learning experience.

Efforts to tinker with or perhaps radically alter this dynamic could disrupt the many organic gains realized across the ecosystem. As such, the FCC and other regulatory entities should continue to play constructive roles in the oversight of the broadband sector going forward. As previously discussed, the FCC has already adopted much-needed changes in an effort to modernize the E-rate program and has released a comprehensive strategy for enhancing an already vibrant broadband market. However, at this point in the evolution of the broadband sector, when this technology is just beginning to be integrated into segments like the education space, adopting new rules that might impede or halt these organic gains should be resisted. Moreover, rather than imposing a series of new regulations on this dynamic technology, policymakers and regulators should take a holistic, forward-looking approach to broadband in an effort to allow it to continue embedding itself in sectors that are greatly benefitting from this unique technology. Otherwise, premature action could result in a series of unforeseen consequences that might slow or halt the many innovative successes described throughout this report.[613]

In order to preserve competition and innovation in the educational technology and advanced communication sectors, the current regulatory approach to broadband should not be altered at this point in time. Maintaining this approach is in the best interests of students, educators, and the entire nation.

7. Conclusion

Education in the United States is at a critical turning point. Educators are under significant pressure to enhance learning outcomes for a diverse and increasingly large number of students. Moreover, students are not being adequately prepared for the 21st century job market, which requires a unique set of critical thinking and technology skills that are not being taught in a coordinated or comprehensive manner. On a more fundamental level, traditional methods of education are being questioned as significant numbers of students drop out of school and as overall student achievement flags. At this critical juncture, broadband-enabled educational technologies are poised to radically transform an antiquated paradigm, improve the quality of education outcomes, and equip student with the skills needed to succeed in the global marketplace.

Broadband is driving innovation across the education sector. Broadband-enabled tools are allowing teachers to develop new methods of instruction that reach and engage students in the increasing number of places where learning occurs – in school, at the library, at home, on their cellphone, and in many other venues. Traditional approaches to preparing and disseminating content are being upended by blogs, wikis, social networks, and other such resources. These and other tools are enabling cost savings, enhancing collection and analysis of student data, and otherwise increasing accountability across the continuum. In the long-term, broadband will enable more individualized learning experiences for students, enabling them to learn at their own pace by using targeted content delivered to their computing device via a high-speed Internet connection.

A robust, efficiently managed broadband infrastructure will allow these and many more impacts to accrue in the near future. All stakeholders – schools, educators, parents, and students – face a number of barriers to further adoption and utilization of these technologies. However, organic efforts that have been nurtured and encouraged by carefully calibrated government support have begun to show that these obstacles can be overcome. As discussed throughout this report, these efforts have demonstrated success in raising the awareness of the benefits of technological tools, providing training, and encouraging collaboration to find targeted solutions aimed at overcoming various impediments. In light of these promising trends, policymakers should continue to finely attune their involvement and focus first and foremost on implementing mechanisms to spur further adoption and utilization of broadband across the education continuum.

ENDNOTES

[1] *See A Nation at Risk*: *The Imperative for Educational Reform*, at p. 7, A Report to the Nation and to the Secretary of Education by the National Commission on Excellence in Education (April 1983), *available at* http://www.ed.gov/pubs/NatAtRisk/index.html.

[2] According to the most recent assessment by the U.S. Department of Education, long term trend data indicate that reading and math test scores have increased across all age groups and ethnicities since the 1970s. *See The Nation's Report Card: Long Term Trend 2008*, at p. 4, National Assessment of Educational Progress Trends in Academic Progress, U.S. Dept. of Education (April 2009), *available at* http://nces.ed.gov/nationsreportcard/pdf/main2008/2009479.pdf.

[3] *See A Nation Accountable: Twenty-five Years after A Nation at Risk*, at p. 1, U.S. Dept. of Education (April 2008), *available at* www.ed.gov/rschstat/research/pubs/accountable/accountable.pdf.

[4] *See* The Official Website of the White House, Issues: Education, http://www.whitehouse.gov/issues/education/.

[5] *Id.*

[6] *See The Condition of Education 2010,* Indicator 1, U.S. Department of Education, National Center for Education Statistics, *available at* http://nces.ed.gov/programs/coe/2010/section1/indicator01.asp (data as of 2008).

[7] These programs include English as a Second Language, adult basic education classes, GED classes, college/university/vocational training, apprenticeships, and courses taken for work or personal interest. *See Issue Brief: Recent Participation in Formal Learning Among Working-Age Adults with Different Levels of Education*, U.S. Department of Education, National Center for Education Statistics 2008-041 (Jan. 2008), *available at* http://nces.ed.gov/pubs2008/2008041.pdf (data collected between 2000 and 2005).

[8] *See* Thomas D. Snyder and Sally A. Dillow, *Digest of Education Statistics 2009,* at p.1, National Center for Education Statistics, U.S. Department of Education (April 2010), *available at* http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2010013 ("*Education Statistics 2009*").

[9] *Id.*

[10] *Id.* at Table 3.

[11] *Id.*

[12] *See The Condition of Education 2010,* Indicator 4, U.S. Department of Education, National Center for Education Statistics, *available at* http://nces.ed.gov/programs/coe/2010/section1/indicator04.asp.

[13] *See The Condition of Education 2010,* Indicator 6, U.S. Department of Education, National Center for Education Statistics, *available at* http://nces.ed.gov/programs/coe/2010/section1/indicator06.asp.

[14] *See Press Release: High School Graduation Rate Improves Over Past Decade; Recent Declines Threaten Progress,* at p. 1, June 9, 2009, Education Week, http://www.edweek.org/media/ew/dc/2009/DC09_PressPackage_FINAL.pdf ("*Education Week 2009*").

[15] *See* Carly Shuler, *Pockets of Potential,* at p. 2, Joan Ganz Cooney Center at Sesame Workshop (2009), *available at* http://www.joanganzcooneycenter.org/pdf/pockets_of_potential.pdf ("*Pockets of Potential*").

[16] A 2007 study by the U.S. Department of Education found that "the average income of persons ages 18 through 65 who had not completed high school was roughly $20,100 in 2005. By comparison, the average income of persons ages 18 through 65 who completed their education with a high school credential, including a General Educational Development (GED) certificate, was nearly $29,700." The study also observed that Dropouts are also less likely to be in the labor force than those with a high school credential or higher and are more likely to be unemployed if they are in the labor force." *See* Jennifer Laird et al.,

Dropout Rates in the United States: 2005, Compendium Report, at p. 1, U.S. Dept. of Education, National Center for Education Statistics, NCES 2007-059 (June 2007), *available at* http://nces.ed.gov/pubs2007/2007059.pdf.

17 *Education Week 2009* at p. 4.

18 *See The Economic Impact of the Achievement Gap in America's Schools,* at p. 9, McKinsey & Company (2009), *available at* http://www.mckinsey.com/App_Media/Images/Page_Images/Offices/SocialSector/PDF/achievement_gap_report.pdf ("*Achievement Gap*").

19 *Id.* at p. 12.

20 *See* Meris Stansbury, *Ten Ways to Boost Learning With Technology,* November 18, 2008, eSchool News, *available at* http://www.eschoolnews.com/news/top-news/index.cfm?i=56081 ("*Learning with Technology*"). A study from 2007 found that "Sixty-five percent of college professors do not believe high school standards prepare students for college, perhaps because they believe standards cover too many topics without targeting the essential knowledge and skills required for college readiness." *See High School Teaching for the Twenty-First Century: Preparing Students for College*, at p. 2, Alliance for Excellent Education, Issue Brief: Sept. 2007, *available at* www.all4ed.org/files/archive/publications/HSTeach21st.pdf.

21 *See* TONY WAGNER, THE GLOBAL ACHIEVEMENT GAP: WHY EVEN OUR BEST SCHOOLS DON'T TEACH THE NEW SURVIVAL SKILLS OUR CHILDREN NEED – AND WHAT WE CAN DO ABOUT IT xix(Basic Books 2008) (citing a2008 study released by the Bill & Melinda Gates Foundation) ("GLOBAL ACHIEVEMENT GAP").

22 For an overview of recent studies regarding international student comparisons, *see Facts for Education Advocates: International Comparisons*, Alliance for Excellent Education (Jan. 2009), *available at* http://www.all4ed.org/files/Facts_For_Education_Adv_Jan2009.pdf.

23 *See, e.g.,* Kenneth Chang, *White House Pushes Science and Math Education*, Nov. 22, 2009, N.Y. Times (reporting on the launch of a White House initiative – Educate to Innovate – that seeks to "enlist companies and nonprofit groups to spend money, time and volunteer effort to encourage students, especially in middle and high school, to pursue science, technology, engineering and math."

24 *Achievement Gap* at p. 8, Exhibit 2.

25 *Pockets of Potential* at p. 2; GLOBAL ACHIEVEMENT GAP xix-xx (comparing high school and college graduation statistics from a number of sources, including the OECD).

26 *See Are They Ready to Work?* at p. 9, Joint Report of The Conference Board, Corporate Voices for Working Families, the Partnership for 21st Century Skills, and the Society for Human Resource Management (2006), *available at* http://www.21stcenturyskills.org/documents/FINAL_REPORT_PDF09-29-06.pdf.

27 *See generally* ERIC HANUSHEK & ALFRED LINDSETH, SCHOOLHOUSES, COURTHOUSES, AND STATEHOUSES: SOLVING THE FUNDING-ACHIEVEMENT PUZZLE'S IN AMERICA'S PUBLIC SCHOOLS (Princeton 2009) (providing a comprehensive overview of the many arguments surround the school funding issue and outlining an alternative framework for performance-based funding system),

28 *See* Eric Hanushek & Alfred Lindseth, *Performance-Based Funding*, Defining Ideas (2009), *available at* http://www.hoover.org/publications/definingideas/62923792.html.

29 *See* John Paul Gee, *Getting Over the Slump: Innovative Strategies to Promote Children's Learning,* at p. 4, Joan Ganz Cooney Center at Sesame Workshop (June 2008), *available at* http://www.joanganzcooneycenter.org/pdf/Cooney_policy_FINAL.pdf ("*Getting Over the Slump*").

[30] *Connecting America: The National Broadband Plan*, at p. 225, FCC (rel. March 2010) ("*National Broadband Plan*").

[31] For example, the 2010 Lemelson-MIT Invention Index found that one of the most effective ways of increasing teens' interest and performance in STEM subjects is through hands-on learning outside of the classroom. As discussed *infra*, broadband is increasingly being used to provide students with these types of interactive and experimental educational experiences. *See* Press Release, *2010 Lemelson-MIT Invention Index Reveals Ways to Enhance Teens' Interest in Science, Technology, Engineering, and Mathematics in the Classroom and Beyond*, Jan. 28, 2010, MIT, *available at* http://web.mit.edu/invent/n-pressreleases/n-press-10index.html.

[32] *See, e.g., National Broadband Plan* at p. 226.

[33] *See* Charles M. Davidson & Michael J. Santorelli, *Barriers to Broadband Adoption*, at p. 68-83, A Report to the Federal Communications Commission, New York Law School (Oct. 2009), *available at* http://www.nyls.edu/user_files/1/3/4/30/83/ACLP%20Report%20to%20the%20FCC%20-%20Barriers%20to%20BB%20Adoption.pdf (highlighting 10 policy and non-policy barriers to further adoption of broadband in the education sector) ("*Barriers to Broadband Adoption*").

[34] In his comprehensive historical overview of American educational technology, Paul Saettler provides a thorough discussion of the many connotations that have been associated with the phrase "educational technology" over the last few centuries. *See generally* PAUL SAETTLER, THE EVOLUTION OF AMERICAN EDUCATIONAL TECHNOLOGY (2000) ("AMERICAN EDUCATIONAL TECHNOLOGY").

[35] *See* Alena R. Treat et al., *Major Developments in Instructional Technology: During the 20th Century,* IDT Record, Department of Instructional Systems Technology, Indiana University (Sept. 2006), *available at* http://www.indiana.edu/~idt/shortpapers/documents/ITduring20.html ("*20th Century Developments*").

[36] *See What is the History of the Field?* Association for Educational Communications and Technology, *available at* http://www.aect.org/standards/history.html ("*AECT History*").

[37] *Id.*

[38] As a result, the FCC set aside 242 television frequencies for noncommercial educational purposes in 1953. *See* Robert A. Levin and Laurie Moses Hines, *Educational Television, Fred Rogers, and the History of Education*, History of Education Quarterly, Vol. 43, No. 2 (Summer 2003), pp. 262-275.

[39] AMERICAN EDUCATIONAL TECHNOLOGY at p. 96.

[40] *Id* at p. 201-202.

[41] One early study, for example, found that media technologies were effective educational tools, due largely to their enhanced level of realism. *20th Century Developments* (citing Edgar Dale's *Cone of Experience*).

[42] *Id.* (citing the Dalton and Winnetka Plans developed by Frederic Burk's staff in the 1920s).

[43] AMERICAN EDUCATIONAL TECHNOLOGY at p. 201-203.

[44] *See* Joan Ganz Cooney, *The Potential Uses of Television in Preschool Education*, Carnegie Corporation (1966), *available at* www.joanganzcooneycenter.org/pdf/jgc-1966-report.pdf ("*Potential Uses of TV for Preschool Education*"). For a more detailed overview of how this report spurred the development of *Sesame Street*, *see* MICHAEL DAVIS, STREET GANG: THE COMPLETE HISTORY OF SESAME STREET (2008).

[45] *Potential Uses of TV for Preschool Education* at p. 7.

[46] For example, some thought these types of shows would help in sharpening "visual discrimination." Visual discrimination refers to the ability of child to discern the differences between different objects, e.g., picking out the duck from among a group of three cats and a duck. *Id*. at p. 31.

[47] *See, e.g.,* Lisa Guernsey, *Sesame Street: The Show that Counts*, June 1, 2009, Newsweek, *available at* http://www.newsweek.com/id/199141 (providing an overview of studies that have found positive impacts on student performance); *cf.* Kay S. Hymowitz, *On Sesame Street, It's All Show*, City Journal (Autumn 1995), *available at* http://www.city-journal.org/printable.php?id=116 (observing that "Stripped of all the noise and color, the fun and the speed, the sophisticated design-school aesthetic and the unfailing wittiness, it is nothing more than a disjointed series of animated flash cards [about 40 per one-hour show], whose inherent blandness and triviality the producers spend millions trying to disguise.").

[48] Larry Cuban notes that television was already being widely used in classrooms in the 1950s. A key enabler of this proliferation was the Ford Foundation, which, through its "Fund for the Advancement of Education underwrote the initial use of [television] in schools and colleges, especially as a tool for relieving the crushing shortage of teachers that resulted from ballooning enrollments. Without [this] sponsorship, classroom video probably would have remained chic gimmickry not unlike the 'talking typewriters' of a few decades earlier." *See* LARRY CUBAN, TEACHERS AND MACHINES: THE CLASSROOM USE OF TECHNOLOGY SINCE 1920 28 (Teacher's College Press 1986) ("TEACHERS AND MACHINES").

[49] *See* Eleanor Cornthwaite et al., "Sesame Street" and "The Electric Company": What Is Their Impact on Teaching Methods? Education Resources Information Center, U.S. Dept. of Education (1974), *available at* http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED126863.

[50] *Id*. at p. 27-31.

[51] *See, e.g.,* Charles Kenny, *Revolution in a Box*, Foreign Policy (Nov./Dec. 2009), *available at* http://www.foreignpolicy.com/articles/2009/10/19/revolution_in_a_box?page=full.

[52] *See, e.g.,* MIZUKO ITO, ENGINEERING PLAY: A CULTURAL HISTORY OF CHILDREN'S SOFTWARE (MIT 2009) ("ENGINEERING PLAY").

[53] For an overview of the modern marketplace, *see* Carly Shuler, *D is for Digital: An Analysis of the Children's Interactive Media Environment With a Focus on Mass Marketed Products that Promote Learning*, Joan Ganz Cooney Center, Sesame Workshop (Dec. 2007), *available at* http://www.joanganzcooneycenter.org/pdf/DisforDigital.pdf ("*D is for Digital*").

[54] *20th Century Developments.*

[55] In 1963, only one percent of secondary schools used computers for instructional purposes, whereas in 1974 over two million students had begun using computers in their classes. By 1975, 55 percent of schools had computer access. *See* Andrew Molnar, *Computers in Education: A Brief History*, at p. 2-3, The Journal, June 1, 1997, *available at* http://thejournal.com/Articles/1997/06/01/Computers-in-Education-A-Brief-History.aspx?Page=1 ("*Computers in Education*").

[56] *Id.* at p. 2 (citing ROGER LEVIEN, THE EMERGING TECHNOLOGY: INSTRUCTIONAL USES OF THE COMPUTER IN HIGHER EDUCATION (1972)).

[57] *Id* at p. 3; *see also 20th Century Developments.*

[58] *Computers in Education* at p. 4 (citing James Kulik et al., *Effectiveness of Computer-based Instruction: An Updated Analysis*, Computers in Human Behavior, 7(1-2), 75-04, (1991)).

[59] *Id* at p. 5.

[60] *See Using Technology to Support Education Reform,* (September 1993), U.S. Department of Education, *available at* http://www2.ed.gov/pubs/EdReformStudies/TechReforms/chap2g.html ("*Education Reform"*).

[61] *Id.*

[62] *Id.* (citing the Office of Technology Assessment 1988).

63 *20th Century Developments* (citing R.A. Reiser, *A history of instructional design and technology*, in TRENDS AND ISSUES IN INSTRUCTIONAL DESIGN AND TECHNOLOGY 26-53 (R.A. Reiser & J.V. Dempsey, eds.) (Prentice Hall 2002) ("*Reiser 2002*")).

64 *Education Reform.*

65 *20th Century Developments* (citing *Reiser 2002).*

66 *Id.*

67 *Id.*

68 *See* MARK WARSCHAUER, LAPTOPS AND LITERACY: LEARNING IN THE WIRELESS CLASSROOM 23 (Teacher College Press 2006).

69 *Id.* at p. 24.

70 *See Access, Adequacy, and Equity in Education Technology,* at p. 10, National Education Association (May 2008), *available at* http://www.edutopia.org/files/existing/pdfs/NEA-Access,Adequacy,andEquityinEdTech.pdf ("*NEA 2008*").

71 *See The 21st-Century Campus: Are We There Yet?* at p. 17, Oct. 13, 2008, CDWG *available at* http://webobjects.cdw.com/webobjects/media/pdf/newsroom/CDWG-21st-Century-Campus-1008.pdf ("*CDWG 2008*").

72 Resources used for this case study include: Maine Learning Technology Initiative, Home, http://www.maine.gov/mlti/index.shtml; Maine Learning Technology Initiative, History, http://maine.gov/mlti/about/history.shtml; Maine Learning Technology Initiative, About, http://maine.gov/mlti/about/index.shtml; Sec. II-1. 5 MRSA §12004-I, sub-§18-C (legislation enacting the creation of the Technology Endowment), *available at* http://maine.gov/mlti/resources/history/statute.pdf; *Teaching and Learning for Tomorrow: A Learning Technology Plan for Maine's Future,* Final Report of the Task Force on the Maine Learning Technology Endowment (Jan. 2001), *available at* http://maine.gov/mlti/resources/history/mlterpt.pdf; David L. Silvernail & Dawn M. M. Lane, *The Impact of Maine's One-to-One Laptop Program on Middle School Teachers and Students, Phase One Summary Evidence, Research Report* #1, at p. iii, Maine Education Policy Research Institute, University of Southern Maine Office (Feb. 2004), *available at* http://www.bryan.k12.oh.us/Forms/MLTIPhaseOne.pdf; Alexis M. Berry & Sarah E. Wintle, *Using Laptops to Facilitate Middle School Science Learning: The Results of Hard Fun*, Center for Education Policy, Applied Research, and Evaluation, University of Southern Maine in collaboration with Bristol Consolidated School (Feb. 2009), *available at* http://usm.maine.edu/cepare/pdf/Bristol_Final_Copy_cover.pdf; David L. Silvernail & Pamela J. Buffington, *Improving Mathematics Performance Using Laptop Technology: The Importance of Professional Development for Success*, Maine Education Policy Research Institute in collaboration with the Maine International Center for Digital Learning, University of Southern Maine (Feb. 2009), *available at* http://usm.maine.edu/cepare/pdf/Mathematics_Final_cover.pdf; and Michael Trucano, *The Maine Thing About 1:1 Computing*, Nov. 13, 2009, EduTech Blog, The World Bank, *available at* http://blogs.worldbank.org/edutech/checking-in-with-the-MLTI.

73 Two of the most vociferous critics have been Larry Cuban and Todd Oppenheimer. *See, e.g.,* Larry Cuban, TEACHERS AND MACHINES; OVERSOLD AND UNDERUSED: COMPUTERS IN THE CLASSROOM (Harvard 2001); *cf. Confessions from a Skeptic on Computers in School*, Jan. 31, 2010, Larry Cuban on School Reform and Classroom Practice Blog, *available at* http://larrycuban.wordpress.com/2010/01/31/confessions-from-a-skeptic-on-computers-in-school/ (noting that some of his previous skepticism has not been borne out but also observing that classroom use of educational technology is still far from universal). *Also see*

generally TODD OPPENHEIMER, THE FLICKERING MIND: SAVING EDUCATION FROM THE FALSE PROMISE OF TECHNOLOGY (2003) ("THE FLICKERING MIND").

74 *See* J. James Cengiz Gulek and Hakan Demirtas, *Learning with technology: The impact of laptop use on student achievement*, at p. 29, Journal of Technology, Learning, and Assessment, vol. 3, no. 2 (2005), *available at* http://escholarship.bc.edu/cgi/viewcontent.cgi?article=1052&context=jtla.

75 *See generally* Michael Russell et al., *Laptop learning: A comparison of teaching and learning in upper elementary classrooms equipped with shared carts of laptops and permanent One-to-One laptops*, Technology and Assessment Collaborative Study, Boston College (Feb. 2004), *available at* http://www.bc.edu/research/intasc/PDF/Andover1to1.pdf.

76 *Id.*

77 *See* William R. Penuel, *Implementation and Effects of One-to-One Computing Iniatives: A Research Synthesis,* at p. 336-337, Journal of Research on Technology in Education (2006), *available at* http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/2a/5b/5b.pdf

78 These studies, which were published in a special edition of the *Journal of Technology, Learning and Assessment* (Vol. 9: Educational Outcomes and Research from 1:1 Computing Settings), are *available at* http://escholarship.bc.edu/jtla/.

79 *See* Damian Bebell & Laura M. O'Dwyer, *Educational Outcomes and Research from 1:1 Computing Settings*, at p. 12, Journal of Technology, Learning and Assessment, Vol. 9, No. 1, *available at* http://escholarship.bc.edu/jtla/vol9/1/.

80 *See* John Timmer, *Despite Problems, Laptops Boost Student Test Scores*, Jan. 25, 2010, Ars Technica, *available at* http://arstechnica.com/tech-policy/news/2010/01/evidence-that-laptop-education-programs-boost-test-scores.ars.

81 *See, e.g.*, MICHAEL BELFIORE, THE DEPARTMENT OF MAD SCIENTISTS: HOW DARPA IS REMAKING OUR WORLD, FROM THE INTERNET TO ARTIFICIAL LIMBS 63 (2009) ("DEPARTMENT OF MAD SCIENTISTS").

82 See Richard N. Katz, *The Tower and the Cloud*, *Higher Education in the Age of Cloud Computing,* at p. 9, EDUCAUSE, *available at* http://www.educause.edu/Resources/TheTowerandtheCloudHigherEduca/163293 ("*Tower and the Cloud*").

83 *See Internet Access in U.S. Public Schools and Classrooms: 1994-2005,* p. 14, The National Center for Education Statistics (November 2006), *available at* http://nces.ed.gov/pubs2007/2007020.pdf.

84 *Id.*

85 *Id* at p. 4.

86 *Id* at p. 7; *see also 20th Century Developments*.

87 *Tower and the Cloud* at p. 9.

88 *Computers in Education* at p. 9.

89 *Id.*

90 *Id.*

91 *Id.*

92 *20th Century Developments* (Citing *Reiser 2002).*

93 *Id.*

[94] *Id*.

[95] TEACHERS AND MACHINES at p. 9 (quoting Edison in 1922).

[96] THE FLICKERING MIND at p. 10 (quoting Frederic Golden, *Here Come the Microkids*, May 3, 1982, Time).

[97] *See* Press Release, *U.S. Department of Education Study Finds that Good Teaching can be Enhanced with New Technology; Analysis of Controlled Studies Shows Online Learning Enhances Classroom Instruction*, June 26, 2009, U.S. Department of Education, *available at* http://www.ed.gov/news/pressreleases/2009/06/06262009.html.

[98] *See Transforming American Education: Learning Powered by Technology*, at p. 9-12, U.S. Dept. of Education (Nov. 2010), *available at* http://www.ed.gov/sites/default/files/netp2010.pdf ("*National Ed Tech Plan*").

[99] *National Broadband Plan* at p. 226.

[100] *See* Steve Midgeley, *Gaps in Broadband for Education,* Nov. 25, 2009, FCC Blogband, *available at* http://blog.broadband.gov/?entryId=16369.

[101] *National Broadband Plan* at p. 37-42 (finding that only 5 percent of census tracts in the U.S. are without a wireline broadband providers and that less than 2 percent are without a 3G mobile provider); *The Broadband Availability Gap*, at p. 17, FCC (July 2010) (finding that about 7 million out of 130 million housing units – or a little more than five percent of all housing units – in the U.S. lack access to broadband service that meets the Commission's more rigorous upload/download speed standard for broadband), available at http://download.broadband.gov/plan/the-broadband-availability-gap-obi-technical-paper-no-1.pdf ("*Broadband Availability Gap*")

[102] *See* John Horrigan, *Broadband Adoption and Use in America,* at p. 5, OBI Working Paper No. 1, FCC (Feb. 2010), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296442A1.pdf ("*Broadband Adoption and Use in America*"); *Exploring the Digital Nation: Home Broadband Internet Adoption in the United States*, at p. 17, Economic & Statistics Administration and NTIA (Nov 2010), *available at* http://www.ntia.doc.gov/reports/2010/ESA_NTIA_US_Broadband_Adoption_Report_11082010.pdf ("*NTIA Broadband Adoption Report 2010*").

[103] It is estimated that companies invested approximately $30 billion in broadband infrastructure in 2009. *See, e.g.*, Robert W. Crandall & Hal J. Singer, *The Economic Impact of Broadband Investment*, at p. 12, 38-43 (Feb. 2010) (observing that between 2003 and 2009, communication service providers invested over $190 billion in last-mile broadband technologies and estimating the service providers will likely invest an average of $30 billion in broadband networks between 2010 and 2015) ("*Economic Impact of Broadband Investment*").

[104] *Broadband Availability Gap* at p. 19-20 (noting that "Due to higher network costs per home passed, most of the unserved are located in less dense and/or rural areas.").

[105] *National Broadband Plan* at p. 236.

[106] The 2009 American Recovery and Reinvestment Act (ARRA) created a Broadband Technology Opportunities Program within the National Telecommunications and Information Administration (NTIA) of the Department of Commerce. The grant program distributed $4.7 billion to fund the deployment of broadband infrastructure in unserved and underserved areas in the country, and to help facilitate broadband use and adoption. An additional $2.5 billion in loans and grants were administered by the Rural Utilities Service. *See Bill Summary: Energy and Commerce Provisions on Healthcare, Broadband and Energy,* U.S. House of Representatives Committee on Commerce, Feb. 12, 2009, *available at* http://energycommerce.house.gov/Press_111/20090212/economiceecoverysummary.pdf ("*ARRA Summary*").

[107] *See generally* Michael J. Copps, *Bringing Broadband to Rural America: Report on a Rural Broadband Strategy*, FCC (rel. May 22, 2009), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-291012A1.pdf ("Bringing ubiquitous and affordable broadband services to rural America will improve the quality of education, healthcare, and public safety in rural America, among other benefits," at para. 15; "Broadband build-out to rural America also can enhance educational opportunities and the likelihood of academic achievement. Students without access to broadband cannot do the same type of homework as their counterparts who enjoy access to broadband, and students in certain rural areas are often many miles away from advanced educational institutions, such as colleges and universities. Broadband can significantly improve the quality of education by providing students in rural America with the ability to do online research, interact with their teachers and schools from home, and obtain college credit and college degrees, even though they are not physically on campus," at para. 19).

[108] *Id.* at n. 118 ("The Distance Learning and Telemedicine programs provide a combination of loans and grants to improve educational and health care opportunities. The grant program focuses primarily on connecting students and teachers or medical providers and patients at separate locations, while the loan and combination loan/grant program seeks to fund additional resources to improve medical care and education. Funds generally are used to finance broadband infrastructure, purchase land and buildings, acquire end-user and other equipment, and provide technical assistance and instruction." (citations omitted)). Additional information can be found *at* USDA, Distance Learning and Telemedicine Program, http://www.usda.gov/rus/telecom/dlt/dlt.htm.

[109] *NEA 2008* at p. 1.

[110] *Id.* at p. 2. *See also Barriers to Broadband Adoption* at p. 78-80; *National Broadband Plan* at p. 233 (noting that "while teacher use of technology continues to grow, most teachers still do not use technology in their classrooms for many key activities." (citations omitted)).

[111] *Barriers to Broadband Adoption* at p. 72-73.

[112] *National Broadband Plan* at p. 236 (citing a 2006 study released by the U.S. Department of Education's National Center for Education Statistics).

[113] According to the U.S. Department of Education, "an estimated 100 percent of public schools had one or more instructional computers with Internet access" at the beginning of the 2008-2009 school year. *See Educational Technology in U.S. Public Schools: Fall 2008*, at p. 2, National Center for Education Statistics, U.S. Dept. of Education (April 2010), *available at* http://nces.ed.gov/pubs2010/2010034.pdf ("*Ed Tech: Fall 2008*").

[114] *See* U.S. Department of Education, National Center for Education Statistics, Question: How many schools have access to the Internet?, http://nces.ed.gov/fastfacts/display.asp?id=46. The FCC has observed that individual schools and school districts across the country use a wide array of broadband connection technologies to get online. These include direct fiber, T-1 lines, and wireless connections. *National Broadband Plan* at p. 236.

[115] *See High-Speed Broadband Access for All Kids: Breaking Through the Barriers*, at p. 6, State Educational Directors Association (June 2008), available at http://www.setda.org/web/guest/2020/broadband.

[116] The FCC revised its definition of broadband in 2008, increasing the minimum speed necessary to qualify as a broadband connection from 200 kb/s to 786 kb/s. *See, e.g.,* Anne Broache, *FCC Approves New Methods for Tracking Broadband's Reach*, March 19, 2008, CNET News.com, *available at* http://news.cnet.com/8301-10784_3-9898118-7.html.

[117] *See* Tom Rolfes and Tammy Stephens, *21st Century Networks for 21st Century Schools: Making the Case for Broadband*, at p. 3, CoSN ("*21st Century Networks*").

[118] *Breaking Through the Barriers* at p. 4; *National Broadband Plan* at p. 236.

[119] *Ed Tech: Fall 2008* at Table 1 (this figure excludes laptops on carts).

[120] *Id.*

[121] *Id.*

[122] *NEA 2008* at p. 9.

[123] *Broadband Adoption and Use in America* at p. 7. However, the broadband adoption rate in single-parent households remains below the overall national average. *NTIA Broadband Adoption Report 2010* at p. 8.

[124] *See* Aaron Smith, *Home Broadband Adoption 2010*, at p. 7-8, Pew Internet & American Life Project (Aug. 2010), *available at* http://pewinternet.org/Reports/2010/Home-Broadband-2010.aspx ("*Home Broadband Adoption 2010*") . In its study, measuring adoption rates through the end of 2009, NTIA found that 49 percent of African-Americans and 36 percent of households earning less than $25,000 per year had adopted broadband. *NTIA Broadband Adoption Report 2010* at p. 8.

[125] A 2003 survey found that just 41 percent of students in the eighth grade who take part in the free and reduced lunch program had home Internet access in 2003, compared to 72 percent for those not participating. *See* Karen Kaminski, Pete Seel, and Kevin Cullen, *Technology Literate Students? Results from a Survey*, at p. 34, Educause Quarterly (2003), *available at* http://net.educause.edu/ir/library/pdf/eqm0336.pdf ("*Technology Literate Students*").

[126] *See Connected to the Future,* at p. 6, Corporation for Public Broadcasting, http://www.cpb.org/stations/reports/connected/connected_report.pdf (*"Connected to the Future"*).

[127] *Id*. According to U.S. Census data from 2005, less than half – 45 percent – of blacks used a computer at home, compared to over 60 percent for both Whites and Asians. *See Computer and Internet Use in the United States: October 2007*, Table 4 - Reported Computer and Internet Access for Individuals 15 Years and Older, by Selected Characteristics: 2005, U.S. Census Bureau, *available at* http://www.census.gov/population/socdemo/computer/2007/tab04.xls.

[128] *See A Resource Guide Identifying Technology Tools for Schools*, at p. 7, The state Educational Technology Directors Association (SETDA) and the National Association of State Title I Directors (NASTID), September 2009, *available at* http://www.setda.org/c/document_library/get_file?folderId=295&name=DLFE-490.pdf.

[129] *Id*.

[130] *Id*.

[131] *See* Elaine Allen and Jeff Seaman, *Online Nation*: *Five Years of Growth in Online Learning,* at p. 3, The Sloan Consortium (October 2007) ("Higher costs for online development and delivery are seen as barriers among those who are planning online offerings, but not among those who have online offerings."); *see also Barriers to Broadband Adoption* at p. 73.

[132] *See* Katie Ash, *Mobile Learning Costs Add Up,* March 18, 2010, Education Week, *available at* http://www.edweek.org/ew/articles/2010/03/18/26cost.h29.html.

[133] *Id*.

[134] *Id*.

[135] *See, e.g.,* CURTIS J. BONK, THE WORLD IS OPEN: HOW WEB TECHNOLOGY IS REVOLUTIONIZING EDUCATION 91-137 (2009) (describing a variety of examples of how the Internet is being used to supplement traditional classroom learning) ("THE WORLD IS OPEN"). Additional examples are provided throughout the remainder of this paper.

136 *See* Diana G. Oblinger and James L. Oblinger, *Educating the Net Generation,* at p. 2.3, Educause (2005) ("*Educating the Net Generation"*).

137 *Id*.

138 *See* Victoria J. Rideout et al., *Generation M2: Media in the Lives of 8- to 18-year Olds*, at p. 2, Kaiser Family Foundation (Jan. 2010), *available at* http://www.kff.org/entmedia/upload/8010.pdf ("*Generation M2*") ("Over the past five years, young people have increased the amount of time they spend consuming media by an hour and seventeen minutes daily, from 6:21 to 7:38 – almost the amount of time most adults spend at work each day, except that young people use media seven days a week instead of five.").

139 *See* Elizabeth A. Vandewater et al., *Digital Childhood: Electronic Media and Technology Use Among Infants, Toddlers, and Preschoolers*, at p. 1010, Pediatrics, Vol. 119 No. (May 2007), *available at* http://pediatrics.aappublications.org/cgi/reprint/119/5/e1006.pdf.

140 *Educating the Net Generation.*

141 *Id.*

142 *See* Sydney Jones and Susannah Fox, *Generations Online in 2009* at p. 2, Pew Internet & American Life Project, *available at* http://www.pewinternet.org/Reports/2009/Generations-Online-in-2009.aspx (observing that "93 percent of teenagers age 12-17 went online in 2008, compared to 85 percent of adults age 25-29 and 78 percent of those ages 50-54").

143 *See* Amanda Lenhart et al., *Social Media & Mobile Internet Use Among Teens and Young Adults*, at p. 7, Pew Internet & American Life Project (Feb. 2010), *available at* http://www.pewinternet.org/~/media//Files/Reports/2010/PIP_Social_Media_and_Young_Adults_Report.pdf ("*Social Media Use Among Teens – 2010*").

144 *See* Amanda Lenhart, *Presentation: Teens and Social Media – An Overview*, Slide 5, April 10, 2009, Pew Internet & American Life Project, *available at* http://www.pewinternet.org/Presentations/2009/17-Teens-and-Social-Media-An-Overview.aspx ("*Teens and Social Media*").

145 *See Teens Do Not Consider a lot of Their Electronic Texts as Writing,* April 24, 2008, Pew Trusts, *available at* http://www.pewtrusts.org/news_room_detail.aspx?id=38268 ("*Teens and Writing*).

146 *Id.*

147 *Id.*

148 *See* Donna St. George, *Parents Use 'Digital' Grounding as a 21st Century Grounding Tool*, Sept. 5, 2010, Wash. Post., *available at* http://www.washingtonpost.com/wp-dyn/content/story/2010/09/05/ST2010090503851.html.

149 *Social Media Use Among Teens – 2010* at p. 22.

150 Twitter users tend to be in their late twenties and early thirties. *Id.* at p. 3.

151 *Id.* at 2.

152 *See* John Palfrey and Urs Gasser, BORN DIGITAL: UNDERSTANDING THE FIRST GENERATION OF DIGITAL NATIVES 4 (2008). This generation is the subject of a wide range of scholarship. Other important recent works on the subject of how technology impacts and shapes the lives of "natives" include: DON TAPSCOTT, GROWN UP DIGITAL (2008); MIZUKO ITO ET AL., HANGING OUT, MESSING AROUND, AND GEEKING OUT: KIDS LIVIGING AND LEARNING WITH NEW MEDIA (MIT 2009).

153 *See* Jeanne Wellings and Michael H. Levine, *The Digital Promise: Transforming Learning with Innovative Uses of Technology,* at p. 10, Joan Ganz Cooney Center at Sesame Workshop (October 2009), *available at*

http://www.joanganzcooneycenter.org/pdf/Cooney%20Apple_Whitepaper_jp10-23-09.pdf ("*Digital Promise*").

154 *Id.*; *see also* ENGINEERING PLAY at p. 82-84 (discussing the impacts of video games on how children learn and participate in education).

155 *Digital Promise* at p. 10.

156 *D is for* at p. 17 (citing a study by Cable in the Classroom, 2007).

157 *See Ready to Learn Initiative Summative Evaluation,* October 14, 2009, Center for Children & Technology, *available at* http://cct.edc.org/ready_to_learn.asp.

158 *See* Sharon Collins, *Virtual Worlds in Education,* EDUCAUSE Evolving Technologies Committee (December 2008), *available at* http://net.educause.edu/ir/library/pdf/DEC0801.pdf.

159 A more detailed listing of virtual worlds targeted at young children can be found at, Common Sense Media, Reviews: Virtual Worlds, http://www.commonsensemedia.org/website-reviews/all-ages/virtual+worlds?action=new-releases.

160 *See Evaluation of Evidence-Based Practices in Online Learning,* at p. xi, U.S. Department of Education, Center for Technology in Learning (2009), *available at* http://www.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf ("*Evaluation of Online Learning*").

161 THE WORLD IS OPEN at p. 98 (citing a study by Project Tomorrow, *Learning in the 21st Century: A National Report on Online Learning* (2008), *available at* http://www.blackboard.com/Solutions-by-Market/K-12/Learn-for-K12/Leadership-Views/Education-in-the-21st-Century.aspx).

162 *See* Clayton M. Christensen and Michael B. Horn, *How Do We Transform Our Schools?* Education Next, Vol. 8, No. 3 (Summer 2008), at http://educationnext.org/how-do-we-transform-our-schools.

163 For an overview of blended learning, *see* Charles Dziuban et al., *Research Bulletin: Blended Learning*, Educause (March 2004), *available at* http://www.educause.edu/ir/library/pdf/ERB0407.pdf.

164 *See* Cheryl Lemke and Ed Coughlin, *Leadership for Web 2.0 in Education: Promise and Reality,* at p. 7, Metiri Group, Commissioned by CoSN through support from the John D. and Catherine T. MacArthur Foundation (May 2009), *available at* http://www.cosn.org/Portals/7/docs/Web%202.0/CoSN%20Report%20042809Final%20w-cover.pdf (detailing the results of a survey that found that an increasing number of educators and administrators are beginning to integrate Web 2.0 tools into curricula) ("*CoSN Web 2.0 Study*").

165 *See* Lauren Barack, *Twittering Dante,* April 1, 2009, School Library Journal, *available at* http://www.schoollibraryjournal.com/index.asp?layout=talkbackCommentsFull&talk_back_header_id=6594667&articleid=ca6647718.

166 *Pockets of Potential* at p. 14 (citing a 2008 NPD Group study that found "[m]obile device ownership among children ages 4-14…experienced double-digit growth since 2005"); *see also* Amanda Lenhart et al., *Teens and Mobile Phones*, at p. 15. Pew Internet & American Life Project (April 2010), *available at* http://www.pewinternet.org/~/media//Files/Reports/2010/PIP-Teens-and-Mobile-2010-with-topline.pdf (finding that cell phone ownership rates have increased steadily among teenagers of all ages over the last several years); *Generation M2* at p. 18.

167 *Generation M2* at p. 18.

168 *Id.*

169 *Pockets of Potential* at p. 17-21.

[170] *See* Patricia Sobrero, *Social Learning Through Virtual Teams and Communities,* Journal of Extension, vol.46, no.3 (June 2008), *available at* http://www.joe.org/joe/2008june/a1.php ("*Virtual Teams and Communities*"); *CoSN Web 2.0 Study;* S. CRAIG WATKINS, THE YOUNG AND HE DIGITAL: WHAT THE MIGRATION TO SOCIAL-NETWORK SITES, FAMES, AND ANYTIME, ANYWHERE MEDIA MEANS FOR OUR FUTURE 19-46 (Beacon Press 2009).

[171] *Virtual Teams and Communities.*

[172] Information included in this Case Study is primarily derived from various pages on the program's website, Virtual Hall of Science, http://www.nysci.org/learn/research/vhos.

[173] *See, e.g.,* Julius Genachowski, FCC Chairman, *Broadband: Our Enduring Engine for Prosperity and Opportunity*, at p. 4, Remarks before NARUC, Feb. 16, 2010, *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296262A1.pdf (noting the vast potential of broadband-enabled online learning: "Imagine a connected America where kids in poor neighborhoods, living in rural towns or city apartments, can have access in their classrooms to the best teachers in the world, and access in their homes to up-to-date e-textbooks and high-quality tutoring from energized college and grad students around America.") ("*Prosperity and Opportunity*").

[174] *National Broadband Plan* at p. 231 (citing a 2009 studying released by the Center for American Progress).

[175] *Prosperity and Opportunity* at p. 3.

[176] *See* U.S. Dept. of Education: National Center for Education Statistics, Question: How many students with disabilities receive services? http://nces.ed.gov/fastfacts/display.asp?id=64.

[177] *See 2008 Disability Status Report – United States*, at p. 46-51, Rehabilitation Research and Training Center on Disability Demographics and Statistics, Cornell University, *available at* http://www.ilr.cornell.edu/edi/DisabilityStatistics/statusreports/2008-pdf/2008-StatusReport_US.pdf.

[178] *Id.* at p. 38.

[179] *See* Charles M. Davidson & Michael J. Santorelli, *The Impact of Broadband on People with Disabilities*, at p. 26-27, A Report to the U.S. Chamber of Commerce (Dec. 2009), *available at* http://www.uschamber.com/NR/rdonlyres/eg527llrwtht77nu6ifxqxyfyam3pbbdizzwuwwu3kuomn37hitdicjmnox7onfsc3ad4iwevg4babodfjivqtctiad/U%2eS%2eChamberPaperonBroadbandandPeoplewithDisabilities.pdf ("*The Impact of Broadband on People with Disabilities*").

[180] *The Digital Promise* at p. 11.

[181] *Educating the Net Generation,* at p. 2.13.

[182] *Id.*

[183] *Id.*

[184] *Id* at p. 2.12.

[185] *Getting Over the Slump* at p. 13-14.

[186] *See* Clayton M. Christensen and Michael B. Horn, *How Do We Transform Our Schools?* EducationNext, Summer 2008, Vol. 8 No. 3 *available at* http://educationnext.org/how-do-we-transform-our-schools/ ("*EducationNext 2008*").

[187] *Digital Promise* at p. 3 (citing a study by Apple, 2009).

[188] *See, e.g., National Broadband Plan* at p. 228-231.

[189] *Connected to the Future* at p. 8.

[190] *Id.*

191 *See Evaluation of Evidence-Based Practices in Online Learning,* at p. ix, U.S. Department of Education, Center for Technology in Learning (2009), *available at* http://www.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf ("*Evaluation of Online Learning*").

192 *Digital Promise* at p. 3 (citing the International Society for Technology in Education, 2008).

193 *See* Linda A. Jackson et al., *Does Home Internet Use Influence the Academic Performance of Low-Income Children?* Developmental Psychology, Vol. 42, No. 3 (2006).

194 *See* Kallen Tsikalas et al., *Home Computing, School Engagement and Academic Achievement of Low-Income Adolescents: Findings from Year One of a Three Year Study of the CFY Intervention*, at p. 5, Computers for Youth Foundation in collaboration with the Educational Testing Service (2007).

195 *National Broadband Plan* at p. 227.

196 *Id.* at p. 228.

197 Resources used for this Case Study include: Partnership for 21st Century Skills, Framework for 21st Century Learning, http://www.21stcenturyskills.org/index.php?option=com_content&task=view&id=254&Itemid=120; *P21 Framework Definitions*, Partnership for 21st Century Skills, *available at* http://www.21stcenturyskills.org/documents/P21_Framework_Definitions.pdf; ThinkFinity, 21st Century Skills, http://www.thinkfinity.org/21stCenturyHome.aspx; Jay Mathews, *The Latest Doomed Pedagogical Fad: 21st Century Skills*, Jan. 5, 2009, Wash. Post, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2009/01/04/AR2009010401532.html; *enGauge 21st Century Skills*, Metiri Group Report commissioned by the North Central Regional Educational Laboratory (2003), *available at* http://www.metiri.com/21/21%20Century%20Skills%20Final.doc; Metiri Group, Features, http://www.metiri.com/features.html.

198 *National Broadband Plan* at p. 174.

199 *Getting Over the Slump* at p. 13-14.

200 *See* ThinkFinity, 21st Century skills, http://www.thinkfinity.org/21stCenturyHome.aspx.

201 *See* Global Kids, Online Leadership Program, http://www.globalkids.org/?id=5.

202 *Id.*

203 *See Education World, available at* http://www.education-world.com/.

204 *See Distance Education,* Indiana University School of Education, *available at* http://site.educ.indiana.edu/Default.aspx?alias=site.educ.indiana.edu/disted.

205 *NEA 2008* at p. 19.

206 *See Internet Access in U.S. Public Schools and Classrooms: 1994-2005,* at p. 10, National Center for Education Statistics, *available at-* http://nces.ed.gov/pubs2007/2007020.pdf ("*Public Schools*").

207 *NEA 2008* at p. 20.

208 *Id.*

209 *Id.*

210 *Id.*

211 *CoSN Web 2.0 Study* at p. 7.

212 *Id.* at p. 7-8.

[213] *See CDW-G 21st Century Campus Study,* at p. 21, CDW-G (Jan. 2009) ("*21st Century Campus*").

[214] *Id.* at p. 4.

[215] *Public Schools* at p. 9.

[216] *Id.*

[217] *NEA 2008* at p. 3.

[218] *Id.* at p. 14.

[219] *Id.* at p. 15.

[220] *See* J.H. Sandholtz & B. Reilly, *Teachers, not technicians: Rethinking technical expectations for teachers*, 106 Teachers College Record 487-512 (2004).

[221] *See* Yao-Ting Sung & Alan Lesgold, *Software Infrastructure for Teachers: A Missing Link in Integrating Technology with Instruction*, Teachers College Record (2007), *available at* http://www.tcrecord.org/Content.asp?ContentID=14536 (quoting M. Guzdial et al., *Beyond adoption to invention: Teacher created collaborative activities in higher education*, 10 J. of the Learning Sciences 265-279 (2001)) ("*SIT 2007*").

[222] *Id.*

[223] *NEA 2008* at p. 16.

[224] *See, e.g., Barriers to Broadband Adoption* at p. 81-82.

[225] *SIT 2007.*

[226] *21st Century Campus.*

[227] *SIT 2007.*

[228] *21st Century Campus* at p. 6.

[229] *See New Poll: Parents Conflicted About Role of Digital Media in Kids' Lives,* Press Release, May 8, 2008, Joan Ganz Cooney Center, *available at* http://www.joanganzcooneycenter.org/pressroom/press-announcement-poll.html (citing a poll from Common Sense Media and the Joan Ganz Cooney Center). ("*Parents Conflicted*").

[230] *See Informing Communities,* at p. 53, The Knight Commission on the Information Needs of Communities (2009), *available at* https://secure.nmmstream.net/anon.newmediamill/aspen/kcfinalenglishbookweb.pdf.

[231] *The Digital Promise* at p. 8-9.

[232] *National Broadband Plan* at p. 228.

[233] *Id.*

[234] *The Digital Promise* at p. 8-9.

[235] *Id.*

[236] *CoSN Web 2.0 Study* at p. 11.

[237] *See* Kyong-Jee Kim and Curtis J. Bonk, *The Future of Online Teaching and Learning in Higher Education: The Survey Says…*, Educause (2006), *available at* http://www.educause.edu/library/eqm0644 ("*Future of Online Teaching and Learning*").

[238] *See, e.g.*, Charles M. Davidson & Michael J. Santorelli, *The Impact of Broadband on Telemedicine*, at p. 7, A Report to the U.S. Chamber of Commerce (April 2009), *available at* http://www.uschamber.com/NR/rdonlyres/ec5epgwk7vyanosellij36hyzht3udur5ceemxscfgfayigcrkyfuntto6adiwt7s2rw2g73epqddifjvykf7n6pj6h/BroadbandandTelemedicineApril2009.pdf.

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[240] *See* Shannon D. Smith, et. al, *Key Findings, The ECAR Study of Undergraduate Students and Information Technology,* at p. 3, Educause (October 2009), *available at* http://net.educause.edu/ir/library/pdf/EKF/EKF0906.pdf ("*ECAR Study*").

[241] *Id.* at p. 4.

[242] *Id.*

[243] *Id.*

[244] *Id* at p. 6.

[245] *See Background Information About LMS Deployment from the 2008 Campus Computing Survey,* at p. 1, The Campus Computing Project, *available at* http://net.educause.edu/ir/library/pdf/LIVE0914ccp.pdf ("*LMS Deployment*")

[246] *See Blackboard Learn,* Blackboard, *available at* http://www.blackboard.com/Teaching-Learning/Learn-Platform.aspx.

[247] *See Mobile Platform,* Blackboard, *available at* http://www.blackboard.com/Mobile/Mobile-Platform.aspx.

[248] *See* MIT, OpenCourseWare, About, http://ocw.mit.edu/OcwWeb/web/about/about/index.htm.

[249] *See 2009 Program Evaluation Findings – Summary,* MIT, OpenCourseWare, *available at* http://ocw.mit.edu/ans7870/global/09_Eval_Summary.pdf.

[250] *See* MIT, OpenCourseWare, Site Statistics, http://ocw.mit.edu/about/site-statistics.

[251] *See* Katie Hafner, *An Open Mind,* April 8, 2010, The New York Times, *available at* http://www.nytimes.com/2010/04/18/education/edlife/18open-t.html?pagewanted=1&ref=education ("*Open Mind*").

[252] *See* John Seely Brown and Richard P. Adler, *Minds on Fire: Open Education, the Long Tail, and Learning 2.0,* EDUCAUSE Review, vol. 43, no.1 (January/February 2008): 16-32, *available at* http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume43/MindsonFireOpenEducationtheLon/162420 ("*Minds on Fire*").

[253] *See Open Yale Courses, About*, http://oyc.yale.edu/about.

[254] *Open Mind.*

[255] *National Broadband Plan* at p. 227.

[256] *See* Apple.com, iTunes U: About, http://www.apple.com/education/itunes-u/.

[257] *See* Press Release, *iTunes U Downloads Top 300 Million*, Aug. 24, 2010, Apple.com, *available at* http://www.apple.com/pr/library/2010/08/24itunes.html.

[258] *See* I. Elaine Allen & Jeff Seaman, *Learning on Demand: Online Education in the United States 2009*, at p. 1, Sloan Consortium (Jan. 2010), *available at* http://sloanconsortium.org/publications/survey/pdf/learningondemand.pdf.

[259] *See* B. Parsad and L. Lewis. *Distance Education at Degree-Granting Postsecondary Institutions: 2006–07,*

NCES 2009–044, National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education (2008).

260 *Id.*

261 *See Distance Education: Online Courses at Harvard,* Harvard University Extension School, *available at* http://www.extension.harvard.edu/DistanceEd/.

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263 *ECAR Study* at p. 10-11.

264 *Id.*

265 *Pockets of Potential* at p. 13-14.

266 *See* Brian X. Chen, *How the iPhone Could Reboot Education,* December 8, 2009, Wired.com, *available at* http://www.wired.com/gadgetlab/2009/12/iphone-university-abilene/.

267 *Id.*

268 *Id.*

269 *See, e.g.,* Chris Foresman, *iPad Goes Under the Gauntlet at Universities this Fall*, July 21, 2010, Ars Technica, *available at* http://arstechnica.com/apple/news/2010/07/ipad-goes-under-the-gauntlet-at-universities-this-fall.ars.

270 *Id.*

271 *See* Brad Stone, *The Argument for Free Classes via iTunes,* November 17, 2009, The New York Times, *available at* http://bits.blogs.nytimes.com/2009/11/17/the-argument-for-free-classes-via-itunes/ (quoting Martin Bean, former general manager of Microsoft's education products group) ("*The Argument for Free Classes via iTunes*").

272 *Tower and the Cloud* at p. 3-4.

273 *Id.* at p. 4 (noting that "Even campuses in virtual worlds such as *Second Life* and elsewhere draw inspiration from the medieval idea of a city of intellect featuring sacred gardens and other spaces to be secured by walls, gates, and towers.").

274 *Id.* at p. 20-21.

275 *See* The University of Phoenix, About, History, http://www.phoenix.edu/about_us/about_university_of_phoenix/history.html.

276 *See, e.g.,* Zephyr Teachout, *A Virtual Revolution is Brewing for Colleges,* Sept. 13, 2009, Wash. Post, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2009/09/11/AR2009091104312.html.

277 *The Digital Promise* at p. 7.

278 *See* Paul Basken, *States Embrace Student-Data Tracking, With Prodding From White House,* Jan. 3, 2010, The Chronicle, *available at* http://chronicle.com/article/States-Embrace-Student-Data/63376/ (citing a Nov. 2009 survey by the Data Quality Campaign). Many of these changes have been made in response to the U.S. Department of Education's Race to the Top competition. *See, e.g.,* Jennifer Medina, *New York Wins Nearly $700 Million for Education*, Aug. 24, 2010, N.Y. Times (discussing a variety of other changes made by states). The Race to the Top program is discussed in more detail, *infra,* in section 6.

279 *The Digital Promise* at p. 7.

280 *See* New York City Department of Education, ARIS, http://schools.nyc.gov/Accountability/SchoolReports/ARIS/default.htm.

281 *See* Javier C. Hernandez, *Parents will Get Access to Student-Tracking Site*, May 28, 2009, N.Y. Times (noting that "On the site, parents will be able to view overall course grades and scores on state tests, but not individual scores on class assignments. They will also be able to see attendance histories and look at the probability of a student passing state math and English exams, based on how they have scored on periodic city tests. It will also show how their child is doing compared with children at schools serving similar student populations.").

282 *See NIST Definition of Cloud Computing, v. 15,* Oct. 7, 2009, NIST Computer Security Div., *available at* http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc.

283 *See* Brad Wheeler and Shelton Waggener, *Provisioning Above-Campus IT Services: Supply and Demand,* EDUCAUSE Review, vol. 444, no. 6, (November/December 2009), *available at* http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume44/ProvisioningAboveCampusITServi/185223 ("*Above-Campus IT Services*").

284 *National Broadband Plan* at p. 232 (citing a 2006 study by CoSN).

285 *Above-Campus IT Services*.

286 *See Background Information About LMS Deployment form the 2008 Campus Computing Survey,* at p. 2-3, The Campus Computing Project, *available at* http://net.educause.edu/ir/library/pdf/LIVE0914ccp.pdf ("*Campus Computing Survey*").

287 *Id.*

288 *Id.* at p. 3.

289 *See, e.g.,* Agam Shah, *IBM Pushes Cloud Computing to Universities,* March 26, 2008, Info World, *available at* http://www.infoworld.com/d/virtualization/ibm-pushes-cloud-computing-universities-576.

290 *See* Philip J. Goldstein, *Managing the Funding Gap: How Today's Economic Downturn Is Impacting IT Leaders and Their Organizations,* at p. 3-5, EDUCAUSE (Jan. 2009), *available at* http://www.educause.edu/Resources/ManagingtheFundingGapHowTodays/163639 ("*Funding Gap*").

291 *Id* at p. 6-7.

292 *Id.* at p. 6.

293 *Id.*

294 *Id.*

295 *See* Brad Wheeler and Shelton Waggener, *Above-Campus Services: Shaping the Promise of Cloud Computing for Higher Education,* EDUCAUSE Review, vol, 44, no.6 (Nov./Dec. 2009): 52-67, *available at* http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume44/AboveCampusServicesShapingtheP/185222 ("*Cloud Computing for Higher Education*).

296 *Id.*

297 *See* Brad Wheeler and Shelton Waggener, *Provisioning Above-Campus IT Services: Supply and Demand,* EDUCAUSE Review, vol. 44, no.6 (Nov./Dec. 2009), *available at* http://www.educause.edu/EDUCAUSE+Review/EDUCAUSEReviewMagazineVolume44/ProvisioningAboveCampusITServi/185223.

298 *Id.*

[299] *See* Tim Hill, *FCC Workshop: Broadband, Online Learning & Job Creation,* at Slide 9, Aug. 26, 2009, Blackboard, *available at* http://www.broadband.gov/docs/ws_job_training/ws_job_training_hill.pdf (citing U.S. Department of Education, NCES, *2004 Digest of Educaiton Statistics*, at Table 173) ("*Blackboard 2009*").

[300] *See* eLearners.com, Facts and Figures from the Online Education Research, http://www.elearners.com/guide-to-online-education/online-education-research.asp (citing a Vault.com study).

[301] *Digital Quality of Life* at p. 18.

[302] *See* Kermit Kaleba, *Expanded Access to Online Job Training: Opportunities and Limitations,* at Slide 2, August 26, 2009, Presentation before the FCC Broadband Initiative Workshop, The Workforce Alliance, *available at* http://www.broadband.gov/docs/ws_job_training/ws_job_training_kaleba.pdf ("*Workforce Alliance 2009*").

[303] *See IBM Training, available at* http://www-304.ibm.com/jct03001c/services/learning/ites.wss/zz/en?pageType=page&c=a0011023.

[304] *Blackboard 2009* at Slide 9.

[305] *See* Joe Mullich, *A Second Act for E-Learning*, Workforce.com (Feb. 2004), *available at* http://www.workforce.com/section/11/feature/23/62/89/index.html.

[306] IBM Corp, Learning Transformation Story (June 2004), *available at* http://www.tzanis.org/Courses/ClassBlog/archives/files/learning_transformation.pdf.

[307] *See* Press Release, *Bersin & Associates Study Shows Significant Drop in Employee Learning and Development Spending for Second Consecutive Year*, Jan. 13, 2010, Bersin & Associates, *available at* http://www.bersin.com/News/Content.aspx?id=11925 (reporting that spending on corporate learning and development decreased by 11 percent in 2009 and 22 percent over the last two years).

[308] *See Yammering away at the office*, Jan. 30, 2010, The Economist (describing how some firms are designing proprietary social networking tools for use in-house by employees).

[309] *Getting Over the Slump* at p. 15.

[310] *See State Broadband Initiatives,* at p. 5, Alliance for Public Technology and the Communications Workers of America (June 2009), *available at* http://www.apt.org/publications/reports-studies/state_broadband_initiatives.pdf ("*State Broadband Initiatives*").

[311] *See* Alabama Supercomputer Authority, Alabama Research & Education Network, http://www.asc.edu/network/.

[312] *See ASPIN, available at* http://aspin.asu.edu/index.html.

[313] *See Past Projects,* ASPIN, *available at* http://aspin.asu.edu/projects/.

[314] *State Broadband Initiatives* at p. 10.

[315] *See The State of Connectivity: Building Innovation through Broadband*, at p. 74, Final Report of the California Broadband Task Force (Jan. 2008), *available at* http://www.calink.ca.gov/pdf/CBTF_FINAL_Report.pdf.

[316] *State Broadband Initiatives* includes a wealth of additional information regarding some of these initiatives.

[317] *See* OneCommunity, Frequently Asked Questions, http://www.onecommunity.org/Common.aspx?id=332.

[318] *See* OneCommunity, Programs: Education, http://www.onecommunity.org/programs/programs.aspx?id=38.

[319] *See* IDEAL, Home Edition, https://www.ideal.azed.gov/p/home-edition-students.

[320] *See* IDEAL, Home, https://www.ideal.azed.gov/p/.

[321] *Pocket of Potential* at p. 2.

[322] In 2010, state education leaders and policymakers negotiated a draft set of national education standards for K-12 students. *See, e.g.,* Sam Dillon, *States Receive a Reading List: New Standards for Education,* June 2, 2010, N.T. Times ("*States Receive a Reading List*"). Starting as early as the second grade, these standards call on educators to ensure that students are able to "use technology, including the Internet, to produce, publish, and interact with others about writing." *See Enhancing Digital Literacy: National Technology Standards for Students?* March 22, 2010, BroadbandExpanded.com, *available at* http://www.broadbandexpanded.com/2010/03/22/enhancing-digital-literacy-national-technology-standards-for-students/.

[323] *See Six New Characters Foster Global Citizenship From A Floating Island,* Sesame Workshop, *available at* http://www.sesameworkshop.org/initiatives/respect/panwapa.

[324] The Panwapa site – www.panwapa.com – provides a running count of the number of "Panwapa kids."

[325] *Pockets of Potential* at p. 20.

[326] *Id.* at p. 44.

[327] *Id.* at p. 27.

[328] *Id.* at p. 42.

[329] For examples, *see* Rick Broida, *5 Amazing iPad e-Books for Kids*, April 14, 2010, CNET, *available at* http://reviews.cnet.com/8301-31747_7-20002462-243.html.

[330] *Generation M2* at p. 2.

[331] *See* PorchLight Entertainment, Kids, http://www.porchlight.com/kids.asp.

[332] *Id.* at p. 41.

[333] *Id.*

[334] *See* Gina Adams Palmer, *Education In Hand: Spreading Succes Using Palm Handhelds at Florida Pre-K-5,* June 2006, District Administration, *available at* http://www.districtadministration.com/viewarticle.aspx?articleid=699&p=1#0.

[335] *See IBM KidSmart Early Learning Program,* IBM, *available at* http://www.ibm.com/ibm/ibmgives/grant/education/programs/kidsmart.shtml.

[336] *Id.*

[337] *See Pearson Applauds Georgia's Pre-K Program for Serving One Millionth Child,* Nov. 23, 2009, Earth Times, *available at* http://www.earthtimes.org/articles/show/pearson-applauds-georgias-pre-k-program-for-serving-one-millionth-child,1058881.shtml.

[338] *Id.*

[339] *See* North Elementary School, Virtual Library Media Center, http://www.nobl.k12.in.us/North/NorthMedia/index.htm,

[340] Information for this case study was drawn from New York City Department of Schools, Department of Instructional & Information Technology: Model Technology Schools,

http://schools.nyc.gov/Offices/EnterpriseOperations/DIIT/ModelTechSchools.htm; New York City Department of Education, About Us, http://schools.nyc.gov/AboutUs/default.htm.

341 *See* Carnegie Learning, Home, http://www.carnegielearning.com/.

342 *See* Carnegie Learning, Secondary and Post-Secondary Math Curricula Solutions, http://www.carnegielearning.com/products.cfm.

343 *See* Ashley Surdin, *In Some Classrooms, Books are a Thing of the Past,* Oct. 19, 2009, Wash. Post, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2009/10/18/AR2009101802360.html.

344 *Id.* ("[A]ccording to analyst Kathy Mickey of Simba Information, a market research group".)

345 *Id.* ("Given that the average textbook costs $100, he argued, the state could save $400 million if its 2 million high school students used digital math and science texts. The initiative also aims to replace aging hardbound books that don't teach students about the Iraq war, the country's first black president or the Human Genome Project.")

346 *See* Gautham Nagesh, *California Testing iPads as Algebra Textbooks*, Sept. 8, 2010, The Hill's Hillicon Valley Blog, *available at* http://thehill.com/blogs/hillicon-valley/technology/117625-california-testing-ipads-as-algebra-textbooks.

347 *Id.*

348 *Pockets of Potential* at p. 43.

349 *See Needs Assessment,* Project-K-Nect, *available at* http://www.projectknect.org/Project%20K-Nect/K-Nect%20Summary%20.html.

350 *Pockets of Potential* at p. 14.

351 *See* Sam Dillon, *Wi-Fi Turns Rowdy Bus Into Rolling Study Hall*, Feb. 12, 2010, N.Y. Times.

352 *Id.*

353 *See ACU brings iPad, Mobile Learning to West Texas Middle and High School Teachers*, June 17, 2010, ACU News, *available at* http://www.acu.edu/news/2010/100617_iPadRuralTeac.html.

354 *Id.*

355 *See* Science Leadership Academy, About, http://www.scienceleadership.org/drupaled/about.

356 *See Science Leadership Academy: A New Model for Schools*, Feb. 9, 2010, Technically Philly blog, *available at* http://technicallyphilly.com/2010/02/09/science-leadership-academy-a-new-model-for-schools.

357 *See* Fran Smith, *My School, Meet MySpace: Social Networking at School*, Edutopia (April 2007), *available at* http://www.edutopia.org/my-school-meet-myspace.

358 Information for this case study was drawn from: New York City Department of Schools, Department of Instructional & Information Technology: Model Technology Schools, http://schools.nyc.gov/Offices/EnterpriseOperations/DIIT/ModelTechSchools.htm; Brooklyn Technical High School, About Us, http://www.bths.edu/about/mission_statement.jsp?rn=8614294; Meris Stansbury, *iSchools Lift Hopes in NYC*, May 15, 2009, eSchool News, *available at* http://www.eschoolnews.com/2009/05/15/ischools-lift-hopes-in-nyc/; Gene Longo, *NYC iSchool: Rethinking School for the 21st Century*, May 15, 2009, Cisco, *available at* http://blogs.cisco.com/news/comments/nyc_ischool_rethinking_school_for_the_21st_century; Press Release, *High School Graduation Rate Rises Above 60 Percent, Marking the Seventh Consecutive Year of Gains*, June 22, 2009, NY City Dept. of Education, *available at* http://schools.nyc.gov/Offices/mediarelations/NewsandSpeeches/2008-2009/20090622_grad_rates.htm.

[359] *See* Education World, Home, http://www.education-world.com/.

[360] *See* Internet4Classrooms, Home, http://www.internet4classrooms.com/index.htm.

[361] *See* PBS Teachers, Home, http://www.pbs.org/teachers/.

[362] *See* eTech Ohio, Home http://www.etech.ohio.gov/.

[363] *Id.*

[364] *See* ABPC, Home, http://abpc.wikispaces.com/.

[365] *Id.*

[366] *See* Steven Sawchuk, *Growth Model*, Sept. 16, 2009, Education Week, *available at* http://www.teachforamerica.org/assets/documents/091609_Education.Week_Growth.Plan.pdf.

[367] *Id.*

[368] *See* New York City Department of Education, Model Tech Schools: The Goddard School, http://schools.nyc.gov/NR/rdonlyres/CFBC06AD-C55C-4019-8421-07E50437F052/0/Goddardfinalv3.pdf.

[369] Resources used for this Case Study include: MOUSE, Home, www.mouse.org; MOUSE, About, http://www.mouse.org/about-mouse; MOUSE, Why MOUSE Squad? http://www.mouse.org/programs/mouse-squad/why-mouse-squad; MOUSE, MouseTech Source, http://www.mouse.org/programs/mouse-techsource; MOUSE, Impact, http://www.mouse.org/about-mouse/impact; 2005-2008 study by Fordham University's National Center for Schools regarding the MOUSE model, a summary of which is *available at* http://www.mouse.org/sites/default/files/Fordham%20Summary%20for%20Website.pdf.

[370] *See* Paul E. Barton et al., *The Family: America's Smallest School*, at p. 3, Educational Testing Service (2007), *available at* http://www.ets.org/Media/Education_Topics/pdf/5678_PERCReport_School.pdf ("*The Family: America's Smallest School*").

[371] *Id.*

[372] *See* Wisconsin Coalition of Virtual School Families, Home, http://www.wivirtualschoolfamilies.org/home/.

[373] *See* Villanova Preparatory School, About. http://www.villanovaprep.org/about_whatisedline.php.

[374]*Id.*

[375] *See* Common Sense Media, Parent Advice, http://www.commonsensemedia.org/advice-for-parents (registration required).

[376] *See* Common Sense Media, Educators, http://www.commonsensemedia.org/educators (registration required).

[377] *The Family: America's Smallest School* at p. 3.

[378] Resources used in this Case Study include: Computers for Youth, Home, www.cfy.org; Computers for Youth, About Us, http://www.cfy.org/principles.php; Computers for Youth, What we Do, http://www.cfy.org/our-approach.php; Computers for Youth, Professional Development, http://www.cfy.org/teacher-training.php; Computers for Youth, Family Impact, http://www.cfy.org/impact-on-families.php; Timothy Hanrahan, *This Internet Start-up Looks to Conquer an Online Divide*, Jan. 2000, Wall St. J., *available at* http://www.cfy.org/news/01-00_WallStreetJournal.html.

[379] *See* Plato Learning, Home, http://www.plato.com/.

[380] *See* CALI – The Center for Computer-Assisted Legal Instruction, http://www.cali.org/.

[381] *Id.*

[382] A sample syllabus for this course is *available at* home.comcast.net/~dbsocialwork/**secondlife**/SampleMacroSyllabus.doc.

[383] *See* Eve Tahmincioglu, *The Faculty is Remote, but Not Detached,* March 9, 2008, N.Y. Times, *available at* http://www.nytimes.com/2008/03/09/jobs/09starts.html.

[384] *See Tweeting in Class,* Nov. 5, 2009, Inside Higher Ed, *available at* http://www.insidehighered.com/news/2009/11/05/twitter.

[385] *Id.*

[386] *Id.*

[387] *Minds on Fire.*

[388] *See* Enspire Learning, Home http://www.enspire.com/.

[389] *Id.*

[390] *See Quiznos Supports Franchise Owners with Blended Learning,* May 21, 2007, AllBusiness.com, *available at* http://www.allbusiness.com/food-beverage/restaurants-food-service-restaurants-fast/8899336-1.html.

[391] *See Little Planet – Quiznos Sub Commander Game,* OstenInteractive, *available at* http://www.osteninteractive.com/webdesign/quiznos/.

[392] *See AMREF/NCK/Accenture: The Kenya Nurse Upgrading Programme Using eLearning,* AMREF, *available at* http://www.amref.org/info-centre/amref-courses--training-programmes/elearning-programme-/.

[393] *Id.*

[394] *Id.*

[395] *See, e.g.,* Robert Atkinson & Ivy Schultz, *Broadband in America: Where it is and Where it is Going*, at p. 11, Report to the FCC, Columbia University, Institute for Tele-Information (Nov. 2009), *available at* http://www.broadband.gov/docs/Broadband_in_America.pdf ("*Broadband in America*"); *Economic Impact of Broadband Investment*.

[396] *Economic Impact of Broadband Investment* at p. 38-43*; see also* Charles M. Davidson & Bret T. Swanson, *Net Neutrality, Investment & Jobs: Assessing the Potential Impacts of the FCC's Proposed Net Neutrality Rules on the Broadband Ecosystem*, at p. 5-6, New York Law School (June 2010), *available at* http://www.nyls.edu/user_files/1/3/4/30/83/Davidson%20&%20Swanson%20-%20NN%20Economic%20Impact%20Paper%20-%20FINAL.pdf ("*Net Neutrality, Investment & Jobs*").

[397] *See* NTIA, BTOP, http://www2.ntia.doc.gov.

[398] *See* RUS, BIP, http://www.broadbandusa.gov/BIPportal/index.htm.

[399] *See, e.g.,* NTIA, BTOP: Grant Awarded, http://www2.ntia.doc.gov/GrantsAwarded (providing an overview of grants awarded to date).

[400] For a comprehensive overview of recent network deployment announcements, *see Broadband in America* at p. A-2-43.

[401] See Press Release, *AT&T to Invest More Than $17 Billion in 2009 to Drive Economic Growth*, March 10, 2009, AT&T, *available at* http://www.att.com/gen/press-room?pid=4800&cdvn=news&newsarticleid=26597.

[402]*See Verizon to Discuss Plans to Divest Wireline Businesses in 14 States*, May 13, 2009, Verizon Investor Relations, *available at*, http://newscenter.verizon.com/press-releases/verizon/2009/verizon-to-divest-wireline.html; *Broadband in America: Coming sooner, future,* Oct. 28, 2010, The Economist.

[403] *See* Cable Labs, DOCSIS Primer, http://www.cablelabs.com/cablemodem/primer/.

[404] *See, e.g.*, Sean Michael Kerner, *Comcast: DOCSIS 3.0, WiMAX Coming*, Aug. 7, 2009, InternetNews.com, *available at* http://www.internetnews.com/infra/article.php/3833721/Comcast+DOCSIS+30+WiMAX+Coming.htm.

[405] *Barriers to Broadband Adoption* at p. 3-4

[406] *See* Amanda Lenhart, *Cell Phones and American Adults*, at p. 2, Pew Internet & American Life Project (Sept. 2010), *available at* http://pewinternet.org/~/media//Files/Reports/2010/PIP_Adults_Cellphones_Report_2010.pdf.

[407] *See Internet Access Services: Status as of June 30, 2009*, at p. 4, FCC (Sept. 2010), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-301294A1.pdf.

[408] *Generation M2* at p. 3.

[409] *Social Media Use Among Teens – 2010* at p. 4.

[410] *Id.* at p. 3, 14.

[411]*National Broadband Plan* at p. 40 (reporting that 98 percent of the U.S. population lives in census tracts with at least one provider of 3G mobile service).

[412] There are two different 4G standards. The first, WiMAX, will be used by Sprint in collaboration with Clearwire, Intel, Google, Comcast, Time Warner Cable, and Bright House Networks. *See* Marguerite Reardon, *Clearwire to Bring WiMax to 10 More Markets*, Aug. 3, 2009, CNET NEWS, *available at* http://news.cnet.com/8301-1035_3-10301928-94.html?part=rss&subj=news&tag=2547-1_3-0-20. The other standard, Long-Term Evolution (LTE), will be used by AT&T, T-Mobile, and Verizon. *See* Marin Perez, *T-Mobiles Lays Out 3G Plans*, Nov. 11, 2009, Information Week, *available at* http://www.informationweek.com/news/mobility/3G/showArticle.jhtml?articleID=221601338.

[413] *See* Charles M. Davidson & Michael J. Santorelli, *Seizing the Mobile Moment: Spectrum Allocation Policy for the Wireless Broadband Century*, 19 CommLaw Conspectus ___ (forthcoming 2010) (draft on file with the authors).

[414] *See* U.S. Department of Education, Race to the Top Fund, http://www2.ed.gov/programs/racetothetop/index.html. An additional $1.35 billion has been set aside in President Obama's 2011 budget to continue the program for another year. *See* Amanda Paulson, *Obama pushes to add $1.35 billion to Race to the Top grants*, Jan. 19, 2010, Christian Science Monitor, *available at* http://www.csmonitor.com/USA/Education/2010/0119/Obama-pushes-to-add-1.35-billion-to-Race-to-the-Top-grants.

[415] *See* Press Release, *U.S. Department of Education Opens Race to the Top Competition,* November 12, 2009, The White House Blog, *available at* http://www2.ed.gov/news/pressreleases/2009/11/11122009.html ("*Race to the Top*").

[416] Indeed, some think that the program will "appeal to students' penchant for technology and desire for real-world skills by teaching them how to use the software that business and creative professionals rely on daily. State and district leaders have been looking at technology rich programs, and in particular career focused programs to bridge the chasm between student interests, the real world and our schools." *See* Bob Regan, *Integrated Technology Curricula Drive Student Retention and Success,* Nov. 17, 2009, Adobe

Education Leaders, *available at* http://blogs.adobe.com/educationleaders/2009/11/integrated_technology_curricul.html ("*Integrated Tech Curricula*").

417 For a discussion of the federal-state interplay evident in the Race to the Top approach, *see* Michael J. Santorelli, *Regulatory Federalism in the Age of Broadband: A U.S. Perspective*, 2 Policy & Internet 99, 120-121 (2010), *available at* http://www.psocommons.org/policyandinternet/vol2/iss3/art5/.

418 *See* Jesse Lee, *Speeding Up Race to the Top*, Jan. 19, 2010, The White House Blog, *available at* http://www.whitehouse.gov/blog/2010/01/19/speeding-race-top.

419 *Id.*

420 *See, e.g.,* Sam Dillon, *Eastern States Dominate in Winning School Grants*, Aug. 24, 2010, N.Y. Times.

421 *See* Robin J. Lake, *In the Eye of the Beholder: Charter Schools and Innovation*, at p. 6, J. of School Choice (April 2008), *available at* http://www.crpe.org/cs/crpe/download/csr_files/jrn_ncsrp_innovrsrch_apr08.pdf (citing Paul Teske et al., *Does Charter School Competition Improve Traditional Public Schools?* Manhattan Institute (2000)).

422 *Integrated Tech Curricula.*

423 *Id.*

424 *Id.*

425 *Id.*

426 *See* Boston Digital Bridge Foundation, Technology Goes Home, http://www.dbfboston.org/programs.html.

427 *Id.*

428 *Id.*

429 *Id.*

430 *See Adoption Plus,* at p. 2, National Cable & Telecommunications Association (Dec. 2009), *available at* http://i.ncta.com/ncta_com/PDFs/AdoptionPlus_Overview_12.02.09.pdf ("*Adoption Plus*").

431 *Id* at p. 3.

432 *Id.*

433 *See* David Nagel, *10.5 Million PreK-12 Students Will Attend Classes Online by 2014*, Oct. 28, 2009, The Journal, *available at* http://thejournal.com/Articles/2009/10/28/10.5-Million-PreK-12-Students-Will-Attend-Classes-Online-by-2014.aspx (citing *US Self-Paced eLearning Market*, Ambient Insight, 2009) ("*Online Classes 2009*").

434 *Id.*

435 *Future of Online Teaching and Learning* ("[R]espondents predicted that certification and recertification programs would see 10-20 percent growth from present offerings.").

436 *Online Classes 2009* (according to Ambient Insight Chief Research Officer Sam S. Adkins).

437 *See* Ali Jafari, Patricia McGee, and Colleen Carmean, *Managing Courses, Defining Learning: What Faculty, Students, and Administrators Want,* EDUCAUSE Review, vol. 41, no.4 (July/August 2006): 50-71, *available at* http://net.educause.edu/ir/library/pdf/ERM0643.pdf.

438 *Future of Online Teaching and Learning.*

439 *Id.*

440 *Id.; see also Tower and the Cloud* at p. 165.

441 *CoSN Web 2.0 Study* at p. 5 (noting that "The findings [of this study] indicate that, at this point in time, educational mindsets and school cultures do not yet align learning to the realities of the 21st Century. There are, however, also encouraging data which suggest that district administrators do see the educational significance for Web 2.0 and recognize the need for educational innovation.").

442 *Minds on Fire*.

443 *CoSN Web 2.0 Study* at p. 5.

444 *Minds on Fire.*

445 *Id.*

446 *CoSN Web 2.0 Study.*

447 *See* Issue Paper, *Personalized Learning: The Nexus of 21st Century Learning and Educational Technologies,* Pearson, *available at* http://www.pearsoned.com/pr_2009/pearson_personalizedlearning.pdf (citing to the MacArthur study) ("*Personalized Learning*").

448 *Id.*

449 *See* Mary Bart, *Technology Trends in Higher Education: How Web 2.0 Tools are Transforming Learning,* Nov. 17, 2008, Faculty Focus, *available at* http://www.facultyfocus.com/articles/teaching-and-learning/technology-trends-in-higher-education-how-web-20-tools-are-transforming-learning/.

450 *See Twitter in Higher Education: Usage Habits and Trends of Today's College Faculty,* at p. 2, Faculty Report (Sept. 2009), *available at* http://www.facultyfocus.com/free-report/twitter-in-higher-education-usage-habits-and-trends-of-todays-college-faculty/.

451 *See* Erica Perez, *Professors Experiment with Twitter as a Teaching Tool,* April 26, 2000, Journal Sentinel, *available at* http://www.jsonline.com/news/education/43747152.html.

452 *See* Bob Weinstein, *Higher Education Takes Lead in Using Virtual Reality,* June 6, 2009, Troy Media, *available at* http://www.troymedia.com/?p=400

453 *CoSN Web 2.0 Study* at p. 7.

454 *Id.* at p. 11.

455 *Id.* at p. 19.

456 *Id.* at p. 9.

457 Cyberbullying Research Center, Research: Cyberbullying Victimization (chart summarizing Feb. 2010 survey findings), http://www.cyberbullying.us/2010_charts/cyberbullying_victim_2010.jpg

458 *CoSN Web 2.0 Study* at p. 25.

459 *Id.* at p. 26.

460 *Id.* at p. 29.

461 *See, e.g., Internet Safety Policies and CIPA: An E-Rate Primer for Libraries and Schools*, at p. 1, E-Rate Central, *available at* http://www.e-ratecentral.com/CIPA/cipa_policy_primer.pdf.

462 *CoSN Web 2.0 Study* at p. 23.

463 *Id.* at p. 22.

464 *See* Kelly Caraher and Meredith Braselman, *News Release, 2009 School Safety Index Finds Security Improvements Aren't Keeping Pace with Breaches,* May 18, 2009, CDWG, *available at* http://newsroom.cdwg.com/news-releases/news-release-05-18-09.html.

465 *ECAR Study* at p. 3.

466 *Id.* at p. 11.

467 *Generation M2* at p. 3.

468 *See The Horizon Report 2010 Edition,* at p. 9, The New Media Consortium, EDUCAUSE Learning Initiative, *available at* http://wp.nmc.org/horizon2010/.

469 *See* David Nagel, *Apple Launches iPad Mobile Tablet,* Jan. 27, 2010, Campus Technology, *available at* http://campustechnology.com/articles/2010/01/27/apple-launches-ipad-mobile-tablet.aspx.

470 *See* Dian Schaffhauser, *Apple's iPad: The Future of Mobile Computing in Education,* January 27, 2010, Campus Technology, *available at* http://campustechnology.com/Articles/2010/01/27/Apples-iPad-The-Future-of-Mobile-Computing-in-Education.aspx?Page=1.

471 *2010 Horizon Report* at p. 10.

472 *See* Apple.com, iPhone in Business: University of Washington, http://www.apple.com/iphone/business/profiles/university-washington ("*University of Washington*").

473 *Personalized Learning* at p. 2 (citing *Harnessing Innovation to Support Student Success: Using Technology to Personalize Education*, U.S. Department of Education (Oct. 2008)).

474 *Id.* at p. 8-9.

475 *Race to the Top.*

476 *Personalized Learning* at p. 7.

477 *Id.*

478 *Id.*

479 *See* Advanced Academics, About Us, http://www.advancedacademics.com/about.html.

480 *See Personalized Learning Puts Students In A Class Of Their Own,* November 4, 2008, Science Daily, *available at* http://www.sciencedaily.com/releases/2008/10/081027144645.htm ("*iClass*").

481 *Id.*

482 *Id.*

483 *Tower and the Cloud* at p. 11.

484 *See* James Hilton, *The Future for Higher Education: Sunrise or Perfect Storm?,* EDUCAUSE Review (March/April 2006): 60, http://net.educause.edu/ir/library/pdf/ERM0623.pdf (*"Future for Higher Education"*).

485 *Tower and the Cloud* at p. 14-15.

486 *Future for Higher Education.*

487 *Id.*

488 *See, e.g., Barriers to Broadband Adoption* at p. 73-74, 75-78 (identifying several cost-related barriers to more robust adoption of broadband in the education arena); Elaine Allen and Jeff Seaman, *Online Nation*: *Five Years of Growth in Online Learning,* at p. 3, The Sloan Consortium (Oct. 2007) ("Higher costs for online

development and delivery are seen as barriers among those who are planning online offerings, but not among those who have online offerings.”).

489 *Breaking Through the Barriers* at p. 6.

490 *Funding Gap* at p. 3-5.

491 *See* Tom Rolfes and Tammy Stephens, *21st Century Networks for 21st Century Schools: Making the Case for Broadband*, at p. 4-6, CoSN (2009) (“*21st Century Networks*”).

492 *See, e.g.*, *Barriers to Broadband Adoption* at p. 74.

493 *Home Broadband Adoption 2010* at p. 7-8 (reporting on survey results that found that households earning less than $30,000 per year had only a 46 percent home broadband adoption rate and that Blacks had only a 56 percent adoption rate, compared to a national average of 66 percent); *NTIA Broadband Adoption Report 2010* at p. 8.

494 *21st Century Networks* at p. 3.

495*See* Katie Ash, *Schools' Broadband Needs Grow as Ed-Tech Evolves,* Sept. 30, 2008, Education Week's Digital Directions, *available at* http://www.edweek.org/dd/articles/2008/09/30/01broadband.h02.html.

496 These types of efforts have been discussed at length in previous papers in this series. *See, e.g.,* Charles M. Davidson & Michael J. Santorelli, *The Impact of Broadband on Senior Citizens*, p. 31-32, A Report to the U.S. Chamber of Commerce (Dec. 2008), *available at* http://www.uschamber.com/NR/rdonlyres/edp7qgdm6hxo6d7jm365ckwgynjgkihfk27obqr5csczpf3sgmd6vy2xut45vdljkdoz62wa7y55awtolulbkqr57ih/BroadbandandSeniors.pdf; *The Impact of Broadband on People with Disabilities* at p. 43-44; *The Impact of Broadband on Telemedicine* at p. 48-89.

497 *See* South Carolina K-12 School Technology Initiative, http://www.sck12techinit.org/About.htm.

498 *Id.*

499 *Id.*

500 *Adoption Plus* at p.1.

501 *Id.* at p. 3.

502 *Id.* at p. 1.

503 For information regarding the programs that received federal stimulus funding, *see* NTIA, Broadband USA, Grants Awarded: Sustainable Broadband Adoption, http://www2.ntia.doc.gov/sustainableadoption.

504 *Stimulus to Impact Education Technology* (quoting an estimate made by Hilary Goldmann, director of government affairs with the International Society for Technology in Education).

505 *Id.*

506 *BTOP Overview.*

507 *See, e.g.,* Clayton M. Christensen and Michael B. Horn, *Commentary: Don't Prop up Failing Schools*, June 2, 2009, CNN, *available at* http://www.cnn.com/2009/US/06/02/christensen.schools/index.html.

508 *National Broadband Plan* at p. 233-240.

509 *See* National Educational Technology Plan, About, https://edtechfuture.org/?page_id=727.

510 *Id.*

511 This argument has been made by many stakeholders, including the Schools, Health and Libraries Broadband Coalition, which has expressed that "it is extremely important that the eligibility of [urban and suburban] institutions to receive broadband funding not be dictated by the definitions and geographic boundaries that might apply to households." *See* John Windhausen, Jr., *Before the Federal Communications Commission, Comments of the Schools, Health and Libraries Broadband Coalition,* at p. 4, Sept. 4, 2009, *available at* http://net.educause.edu/ir/library/pdf/CSD5725.pdf.

512 H.R. 558 – The Achievement Through Technology and Innovation (ATTAIN) Act of 2009 – was introduced in January 2009. This bill would reauthorize Section IID of the NCLB. Full text of the bill is *available at* http://www.govtrack.us/congress/billtext.xpd?bill=h111-558. In September 2010, the bill was referred to Committee.

513 *See* State Education Technology Directors Association, 2008 Gateway to Graduation Toolkit: ATTAIN Act, http://www.setda.org/web/toolkit2008/student-engagement/attain.

514 *See* Universal Service Administrative Company, Overview of the Schools and Libraries Program, http://www.universalservice.org/sl/about/overview-program.aspx.

515 *Id.*

516 *Breaking Through the Barriers* at p. 22.

517 *See Report to Congressional Requesters, Long-Term Strategic Vision Would Help Ensure Targeting of E-rate Funds to Highest-Priority Uses,* at p. 2, United States Government Accountability Office (GAO) (March 2009) ("*GAO Report*").

518 *Id.*

519 *See, e.g.,* Sheryl Abshire, *Presentation at FCC Workshop: Education,* Aug. 20, 2009, FCC, *available at* http://www.broadband.gov/ws_education.html ("The most widely disseminated criticism of the E-Rate program is its lack of funding."); *Barriers to Broadband Adoption* at p. 75-76.

520 *Breaking Through the Barriers* at p. 23.

521 *Id*. However, per the FCC, "While the E-rate program is capped by FCC regulation at $2.25 billion annually, unused funds from prior funding years may be rolled over to the future, enabling the FCC to disburse more than the annual cap in a given year. In addition, in a given year, the FCC may disburse more than the cap when invoices for funding commitments from prior years are presented for payment." *National Broadband Plan* at p. 157, note 26.

522 "Each year from 1998- 2007, the amount of funding applicants requested exceeded the amount available… From 1998 through 2007, applicants requested a total of about $41 billion in E-rate funding—174 percent of the $23.4 billion in program funding." *GAO Report* at p. 13.

523 *Breaking Through the Barriers* at p. 23.

524 See *In the Matter of Schools and Libraries Universal Service Support Mechanism*, Sixth Report and Order, para. 34-40, FCC 10-175 (rel. Sept. 28, 2010), *available at* http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1001/FCC-10-175A1.pdf ("*FCC E-Rate Order - Sept. 2010*").

525 According to the FCC's September 2010 E-Rate order, the cap for funding year 2010 will be $2.27 billion, up from $2.25 billion. *Id.*

526 *Id.*

527 *See, e.g., National Broadband Plan* at p. 145 (outlining a proposal for a new program focused on connecting all Americans to broadband); *In the Matter of Federal-State Joint Board on Universal Service;*

Lifeline and Link up, Recommended Decision, para. 4, FCC 10J-3 (rel. Nov. 4, 2010), *available at* http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1104/FCC-10J-3A1.pdf.

528 *See* Universal Service Administrative Company, Step 5: Discount Matrix, http://www.universalservice.org/sl/applicants/step05/discount-matrix.aspx.

529 *National Broadband Plan* at p. 236-237.

530 *See, e.g.,* Patricia M. Worthy, *Racial Minorities and the Quest to Narrow the Digital Divide: Redefining the Concept of "Universal Service,"* 26 Hastings Comm. & Ent. L.J. 1, 45 (2003); *Barriers to Broadband Adoption* at p. 76.

531 *GAO Report* at Highlights.

532 *Id.*

533 *See* Laura Devaney, *e-Rate wants to be user friendly*, Sept. 24, 2009, eSchool News, *available at* http://www.eschoolnews.com/news/top-news/index.cfm?i=60880 (*"E-rate User Friendly"*).

534 *GAO Report* at Highlights.

535 *E-rate User Friendly*.

536 *Id*.

537 *FCC E-Rate Order - Sept. 2010* at para. 51-92.

538 *Breaking Through the Barriers* at p. 23.

539 *See* Tamar Lewin, *In a Digital Future, Textbooks are History*, Aug. 8, 2009, N.Y. Times, *available at* http://www.nytimes.com/2009/08/09/education/09textbook.html?_r=3&ref=education.

540 *NEA 2008* at p. 2.

541 *See* Mark Warschauer, *Information Literacy in the Laptop Classroom,* Teachers College Record (2007), *available at* http://www.tcrecord.org/Content.asp?ContentID=14534 (*"Information Literacy"*).

542 *See iAm Laptop Pilot Program Announces Recipients,* Customer Services Newsletter, South Carolina Division of the State CIO, State Budget and Control Board, *available at* http://www.state.sc.us/newsletter/ciocs/200782750524490.8125.html.

543 *See Executive Summary of NYC Connected Learning Proposal*, BTOP, *available at* http://www.ntia.doc.gov/broadbandgrants/applications/summaries/2263.pdf.

544 *See* Computers for Youth, Affiliate Network, http://www.cfy.org/about-affiliate-network.php.

545 *See* Jamie L. Carlacio and Lance Heidig, *Technology and Digital Literacy Digitally: A Collaborative Approach,* at p. 2, MIT, *available at* http://web.mit.edu/comm-forum/mit6/papers/Carlacio.pdf (*"Technology and Digital Literacy"*).

546 *See Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge: A Report to the Nation on Technology and Education,* at p. 1, U.S. Department of Education (1996), *available at* http://www2.ed.gov/about/offices/list/os/technology/plan/national/index.html.

547 *See* BERNIE TRILLING & CHARLES FADEL, 21ST CENTURY SKILLS: LEARNING FOR LIFE IN OUR TIMES 8 (2009).

548 *National Broadband Plan* at p. 225.

549 *See, e.g., Are They Ready to Work?* at p. 9; *National Broadband Plan* at p. 225 (noting educational disparities prevalent among certain minority populations).

550 *See* Scott J. Cech, *Tests of Tech Literacy Still Not Widespread Despite NCLB Goals*, Jan. 29, 2008, Education

Week.

551 *See Horizon Report, 2009 K-12 Edition*, at p. 7, New Media Consortium, *available at* http://www.nmc.org/publications/2009-horizon-k12-report (*"K-12 Horizons 2009"*).

552 *See* Carole Bausell and Elizabeth Klemick, *Tracking U.S. Trends,* March 29, 2007, Education Week.

553 *Id.*

554 *See* Scott J. Cech, *Tests of Tech Literacy Still Not Widespread Despite NCLB Goals*, Jan. 29, 2008, Education Week.

555 *See, e.g.,* ROBERT A. SCHAPIRO, POLYPHONIC FEDERALISM: TOWARD THE PROTECTION OF FUNDAMENTAL RIGHTS 22 (Chicago 2009) (discussing the historical and legal bases for the largely local control of schools) ("POLYPHONIC FEDERALISM").

556 *See* U.S. Department of Education, National Center for Education Statistics: NAEP Overview, http://nces.ed.gov/nationsreportcard/about/.

557 POLYPHONIC FEDERALISM at p. 23 (observing that the "NCLB Act institutes massive federal regulation of the administration of elementary and secondary education in the United States. In return for receiving federal education funds, states must accept provisions that regulate the qualifications of teachers, establish student performance goals, and impose detailed reporting requirements. NCLB requires states to establish proficiency goals for the performance of students. Yearly testing monitors the progress in achieving these benchmarks.").

558 *America's Schools* at p.3.

559 For an overview of the debate surrounding national standards, *see* Paul E. Barton, *National Education Standards: Getting Beneath the Surface*, Educational Testing Service (2009), *available at* http://www.ets.org/Media/Research/pdf/PICNATEDSTAND.pdf.

560 *States Receive a Reading List.*

561 *See* Diane Ainsworth, *Prep Students Get into the GameDesk,* March 20, 2009, USC News, University of South Carolina, *available at* http://uscnews.usc.edu/university/prep_students_get_into_the_gamedesk.html.

562 *Id.*

563 *Id.*

564 *See* One Economy, What we Do: Digital Connectors, http://www.one-economy.com/what-we-do/digital-connectors.

565 *See* Charisse Lillie, *Comcast Digital Connectors: Year One*, Sept. 20, 2010, Comcast Voices blog, *available at* http://blog.comcast.com/2010/09/comcast-digital-connectors-year-one.html.

566 *See* NTIA, Broadband Grants Awarded: Sustainable Adoption, One Economy, http://www2.ntia.doc.gov/grantees/OneEconomyCorp.

567 *National Broadband Plan* at p. 174-176.

568 *See* R.M. Wallace, *A framework for understanding teaching with the Internet,* 41 American Educational Research Journal 447-488 (2004).

569 *SIT 2007.*

570 *See* Catherine Gewertz, *Outside Interests,* March 29, 2007, Education Week.

571 *21st Century Campus* at p. 6.

[572] *Public Schools* at p. 9.

[573] *NEA 2008* at p. 3.

[574] *SIT 2007.*

[575] *See* Adobe Digital School Collection, K-12, http://www.adobe.com/education/k12/adsc/.

[576] *Id.*

[577] *National Broadband Plan* at p. 233.

[578] The U.S. Department of Education's *National Education Technology Plan* addresses some of these barriers by, among other things, encouraging more experimentation with technology in the classroom and enhancing access to professional development training. *National Ed Tech Plan* at p. 44-50.

[579] *See* Kyong-Jee Kim and Curtis J. Bonk, *The Future of Online Teaching and Learning in Higher Education: The Survey Says,* EDUCAUSE Quarterly, Volume 29, Number 4 (2006), *available at* http://www.educause.edu/EDUCAUSE+Quarterly/EDUCAUSEQuarterlyMagazineVolum/TheFutureofOnlineTeachingandLe/157426 (*"Future of Online Teaching and Learning"*).

[580] *Id.*

[581] *Parents Conflicted.*

[582] *Id.*

[583] *Evaluation of Online Learning* at p. ix (noting that "On average, students in online learning conditions performed better than those receiving face-to-face instruction.").

[584] *See* David Nagel, *Is Blended Learning Effective?* Sept. 17, 2008, Campus Technology, *available at* http://campustechnology.com/Articles/2008/09/Is-Blended-Learning-Effective.aspx?Page=1.

[585] The FCC has proposed the creation of a national system of electronic education records, which would include "student demographic and academic information as well as course history, student work, attendance and health data." *National Broadband Plan* at p. 234.

[586] The U.S. Department of Education has done this in the past, most recently with its meta-analysis of studies related to e-learning. *See Evaluation of Online Learning.*

[587] *Parents Conflicted.*

[588] *NDLI* at p. 14.

[589] *Id.* at p. 16.

[590] *National Ed Tech Plan* at p. 75-80.

[591] *Id*. at p. 76.

[592] The U.S. Department of Education launched a separate website dedicated to the public discussion and development of the Plan. Stakeholders had an opportunity to participate in a brainstorming event and to submit resources for use by the Department during the preparation of the Plan. Once a draft is produced, the public will have an opportunity to comment on it via the website. For more information, *see* National Educational Technology Plan, Opportunities for Input, https://edtechfuture.org/?page_id=888.

[593] *See* FCC Broadband.gov, Blogband, http://blog.broadband.gov.

[594] *See* FCC Broadband.gov, Workshops, http://www.broadband.gov/workshops.html.

[595] *See* FCC Broadband.gov, http://www.broadband.gov.

[596] *Digital Media* at p. 49.

[597] *See* CoSN, About, http://www.cosn.org/AboutUs/tabid/4214/Default.aspx.

[598] *See* Kathleen Kennedy Manzo, *Hunting the Internet for Quality Content,* March 26, 2009, Education Week http://www.edweek.org/login.html?source=http://www.edweek.org/ew/articles/2009/03/26/26quality.h28.html&destination=http://www.edweek.org/ew/articles/2009/03/26/26quality.h28.html&levelId=2100 (“*Quality Content*”).

[599] *See Knowledge Map: Content and Curriculum Issues,* at p. 41, infoDev (2009), *available at* http://www.infodev.org/en/Publication.161.html (“*Knowledge Map*”).

[600] *Id.* at p. 42.

[601] *Id.*

[602] *See FREE (Federal Resources for Educational Excellence),* Education World (July 2004), *available at* http://www.educationworld.com/awards/2004/r0104-14.shtml. *See also Federal Resources for Educational Excellence,* U.S. Department of Education, *available at* http://free.ed.gov/.

[603] *About the ERIC Program, ERIC, available at* http://www.eric.ed.gov/ERICWebPortal/resources/html/about/about_eric.html.

[604] *National Broadband Plan* at p. 228.

[605] *See, e.g.,* Ashley Surdin, *In Some Classrooms, Books are a Thing of the Past,* October 19, 2009, Washington Post, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2009/10/18/AR2009101802360.html

[606] *Id.*

[607] *Id.*

[608] Proposed legislation seeking to update the E-Rate program would provide funding for e-readers. *See* Press Release, *Markey Introduces E-Rate 2.0 Bill to Bring Successful Program into 21st Century*, Fed. 9, 2010, Office of Rep. Ed Markey, *available at* http://markey.house.gov/index.php?option=content&task=view&id=3843&Itemid=125.

[609] For example, a 2004 study by CalPIRG found that “65 percent of faculty ‘rarely’ or ‘never’ use the bundled materials in their courses” and that “Online textbooks could significantly lower the retail cost of textbooks.” *See Rip-off 101: How The Current Practices Of The Textbook Industry Drive Up The Cost Of College Textbooks*, CalPIRG (April 2004), *available at* http://www.studentpirgs.org/reports/textbooks/affordable-textbooks-reports/rip-off-101-how-the-current-practices-of-the-textbook-industry-drive-up-the-cost-of-college-textbooks. Similarly, a paper submitted to the U.S. Department of Education’s ERIC observed that “the unbundling of textbook packages appears to represent a partial solution to rising textbook prices and one that deserves more exploration.” *See* James V. Koch, *An Economic Analysis of Textbook Pricing and Textbook Markets*, at p. 11, ACSFA College Textbook Cost Study Plan Proposal (Sept. 2006), *available at* http://www2.ed.gov/about/bdscomm/list/acsfa/kochreport.pdf.

[610] The Higher Education Opportunity Act (HEOA), which was enacted in 2008, requires textbook publishers to “make available the college textbook and each supplemental material as separate and unbundled items, each separately priced.” *See* HEOA, H.R. 4137, Section 133 (c)(2), *available at* www.nacua.org/documents/heoa.pdf.

[611] For example, the FCC has recommended that Congress “consider taking legislative action to encourage copyright holders to grant educational rights of use, without prejudicing their other rights.” *National Broadband Plan* at p. 230.

[612] *See, e.g.,* Charles M. Davidson & Michael J. Santorelli, *Network Effects: An Introduction to Broadband Technology & Regulation*, at p. 3-5, A Report to the U.S. Chamber of Commerce (Dec. 2008), *available at*

http://www.uschamber.com/NR/rdonlyres/ew4ahwhwxqx6rxs4vrjebfzdxqt46nw5a67qsor3pa5jcvdgiuw2mwrmns4xe6kua5ce63mhjdk7ykfbx4ioliesrsa/ChamberIntroBroadbandPaperFinal121708.pdf ("*Network Effects*"); *Net Neutrality, Investment & Jobs; Economic Impact of Broadband Investment*.

[613] Sweeping regulations imposed in the modern telecommunications sector have largely failed to produce their intended goals. Perhaps the most notable example of this is the 1996 Telecommunications Act. *See, e.g., Network Effects* at p. 4.

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