



U.S. DEPARTMENT OF EDUCATION

HARNESSING INNOVATION TO
SUPPORT STUDENT SUCCESS

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PERSONALIZE EDUCATION

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OFFICE OF THE SECRETARY
U.S. DEPARTMENT OF EDUCATION

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Secretary

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Harnessing Innovation to Support Student Success: Using Technology to Personalize Education

OVERVIEW

Technology has transformed the way we communicate. Our children are growing up in a very different world from the one their parents experienced.

For example:

- More than half of young adults in the United States send or receive text messages daily.¹
- Three out of four teens between the ages of 15 and 17 own cell phones.²
- And almost eight out of 10 teens say they've helped an adult do something online that the adult could not do him- or herself.³

Harnessing the power of innovation for the good of our schools is not just a novel enterprise. The nation's health and prosperity depend on it. By leveraging technology, schools can customize instruction and ensure that children who need extra help get it.

In the past, our nation's schools lacked the data to demonstrate who was doing well, who was falling behind, and where those gaps were occurring. With the passage of the *No Child Left Behind Act (NCLB)*, a wealth of information has been collected. Increased transparency has brought about better use of data and built an appetite for change and improvement. With the help of technology, we must now begin to address those expectations in innovative ways.

Education is not a one-size-fits-all enterprise. Just as every child has unique needs, so does every teacher, every school, every district and every state. While real progress has been made in wiring our classrooms and equipping them with new technologies, we have yet to see a profound transformation in the way we deliver education.

Our goal should be to find ways for technology to make teaching and learning more efficient and effective, not more complicated.

In the last 50 years, American ingenuity has put a man on the moon, a rover on Mars, and computers in our businesses, our homes and even our pockets. We have mapped the human genome and developed life-extending drugs, such as treatments for AIDS. Having every child on grade level by 2014 is another ambitious goal, and it is one we can accomplish. With the right support for teachers, including new technologies, we can close the achievement gap and reach our goal of leaving no child behind.

Yet, we have a "rate-of-change" factor to consider as well. Our population growth will not keep pace with that in the developing world. For every child born in America today, more than four

¹ John Horrigan, *Mobile Access to Data and Information*. (Pew Internet and American Life Project, 2008), p. 5.

² Amanda Lenhart, Mary Madden, Alexandra Rankin Macgill and Aaron Smith, *Teens and Social Media*. (Pew Internet and American Life Project, 2007), p. 21.

³ Amanda Lenhart and Mary Madden, *Teen Content Creators and Consumers*. (Pew Internet and American Life Project, 2005), p. 5.

are born in China, and almost six are born in India. As these two countries also gear up their education systems for this global economy, they possess more students and thus more raw potential than we do. As such, we cannot compete solely on volume, we must compete on quality; we must do a better job of educating each and every one of our children.

DEFINING THE NEW NEED

Our 20th-century education system was built on an industrial model fit for an industrial economy. The expectation was that the bulk of our workforce would go into jobs that required only a high school diploma—or even less. We now live in an information age that requires much more than a high school diploma. Our education system must reflect the skills and knowledge essential to succeed in this new era.

One key differentiator between the industrial age and the information age has been the transfer in the locus of control. In the industrial age, control was with the supplier. As Henry Ford famously said, “Any customer can have a car painted any color that he wants so long as it is black.” In the information age control is with the individual. Today’s businesses succeed by developing personalized responses to individual needs. Education must embrace this same approach if we are to maximize the potential of every student.

LAYING THE FOUNDATION FOR INFORMATION AGE EDUCATION

The federal government is a minority investor in our education system. But it is clear that strategic government investments, in partnership with the private and philanthropic sectors, can have a profound impact. Over the past decade, the federal investment in technology has not been well targeted, resulting in islands of innovation, not a sea of change.

A decade ago in many sectors of our economy, a paradox emerged wherein the large investments in computer technology did not result in the expected increases in corporate productivity. This productivity paradox was not resolved until businesses retooled their operations to take advantage of affordances that technology provided. By changing business practices to harness technology, efficiencies were achieved and new businesses and new business models were created.

Education is at a similar crossroads. The large public investments in educational technology have not yet produced in the education sector corresponding increases in productivity as measured by academic achievement. This is not to say that these investments have been without impact. Since 1998 the federal investment in educational technology has exceeded \$18 billion (\$14 billion through the Federal Communication Commission’s Schools and Libraries Program of the Universal Service Fund, or E-rate program, and almost \$4 billion through education technology programs under *NCLB*). Nearly all elementary and secondary schools are now connected to the Internet, up from only 50 percent in 1995.⁴ In addition, our investments in data systems have

⁴ John Wells and Laurie Lewis, *Internet Access in U.S. Public Schools and Classrooms: 1994–2005* (NCES 2007-020). (Washington, D.C.: U.S. Department of Education, National Center for Education Statistics, 2006), p. 4.

created a foundation of information upon which we can build more accurate reporting, more responsive instruction and more effective accountability systems.

However, these improvements in infrastructure have not yet been matched by systemic improvements in the classroom. While some of the limited research available shows that technology has provided modest increases in learning, the education system has not made full use of technology in ways that can achieve the transformations seen in our economy, society and elsewhere.

SECRETARY'S ROUNDTABLES

In response to these education and competitiveness challenges, over the past 18 months Secretary Spellings has convened a series of three roundtable discussions with representatives from across the education and technology landscape, from teachers to CEOs, and a fourth roundtable with students. The conversations were frank and informative and provided a view into the potential, and the challenges of harnessing technology to help transform education.

Based on the feedback received from the roundtables, outlined below are five key areas where we believe federal, state and local governments can collaborate to build on the success of *NCLB* and accelerate the transformation of our education system. Investments in these strategic areas are not designed to create more islands of innovation, but to support a fundamental sea change in our education system. If we are successful, not only will no child be left behind, but also every child will be inspired to achieve to his or her potential.

The five key areas are:

1. Online Learning and Virtual Schools
2. Transforming Data Into Knowledge and Action
3. Broadband Connectivity
4. Research Efficacy and Impact
5. School Leadership and Professional Preparation

Online Learning and Virtual Schools

Description: The Internet, Web 2.0 services and more affordable computing platforms have ushered in new models for shopping, conducting business, consuming entertainment and engaging with government. These same technologies can help us redefine the way education is provided to students so that learning can take place anytime, anywhere and at any pace. Today, online learning and virtual schools are providing individual access to learning opportunities—personalized not only to student learning needs and interests, but available when and where students are interested in learning, be that at home or at school.

As of 2007, there were 25 state virtual schools⁵ and over 173 virtual charter schools in the United States.⁶ Just as many brick and mortar stores offer customers the chance to shop online, many traditional public schools are offering students the chance to learn online. More than 39 percent

⁵ *Education Week*, "Technology Counts 2008." 27(30).

⁶ Bill Tucker, *Laboratories of Reform: Virtual High Schools and Innovation in Public Education*. (Washington, D.C.: Education Sector, 2007), p. 2.

of public secondary schools provide students with the chance to take online courses.⁷ Since 2002 there has been a 60 percent increase in K–12 distance education enrollments in the United States, and the range of course work extends from Advanced Placement (AP) and college preparation to remedial and credit recovery courses.⁸

Supplemental educational services (SES) providers also are offering extra assistance to students through online services. Just as adults have come to expect 24/7 access to many services from online banking to online shopping, so have students come to expect 24/7 access to services that support their learning needs. Some service providers offer students help with their homework, maybe consisting of factoring a polynomial late at night. Others offer scheduled interactive tutoring sessions to help students catch up on subjects ranging from math to social studies.

These technology services have played an important role in supporting the SES provision in *NCLB* that targets extra assistance to students in struggling schools. As of 2004, of the 15 most widely approved state SES providers, at least six use technology in a significant way.⁹ Students also are turning to supplemental materials on the Web from videos to interactive demonstrations.

Why It’s Promising: Virtual schooling is driving fundamental transformation of our education system. The curriculum is personalized and available anytime, anywhere, which allows it to meet the needs of diverse students. Students in rural locations now have access to AP courses that were once cost prohibitive for their schools to offer. Traditional schools can augment their existing courses by offering online foreign language courses, including those that support the goals of the president’s National Security Language Initiative. Districts can better utilize teaching staff by connecting classrooms through videoconferencing. Students can take courses that are customized for their own unique needs and interests. And, teachers and parents have real-time access to indicators of student performance.

In addition, almost two-thirds of postsecondary institutions today offer some learning at a distance, and while K–12 enrollments in online learning have increased significantly, the increases in postsecondary education have been dramatic. These increases, coupled with the rapid rise of online learning in the corporate sector, suggest that offering additional online learning experiences to K–12 students will provide preparation for the kind of learning they will likely be engaged in for the rest of their academic experiences and throughout their careers.

Next Steps: While state and local entities explore the practical and procedural aspects of online delivery, the federal government should expand its capacity to research and survey the pedagogical potential and instructional value of online learning and online teacher preparation, providing both perspective and insight to guide state and local implementation.

Transforming Data Into Knowledge and Action

⁷ Izabella Zandberg and Laurie Lewis, *Technology-Based Distance Education Courses for Public Elementary and Secondary School Students: 2002–03 and 2004–05* (NCES 2008–008). (Washington, D.C.: U.S. Department of Education, National Center for Education Statistics, 2008), p. 11.

⁸ *Ibid.*, p. 16.

⁹ Steve Fleischman, *The Role of Educational Technology in Meeting the Promise of Supplemental Education Services*, in *Helping Practitioners Meet the Goals of No Child Left Behind*. (Washington, D.C.: U.S. Department of Education, 2004), p. 48.

Description: With the passage of *NCLB*, the past six years have demonstrated the power of increased access to education data to inform decision-making, increase transparency and provide the information necessary to improve program performance. Educators and policymakers need timely, reliable data to make better decisions related to student achievement. Throughout the country, districts are beginning to use sophisticated data systems to analyze performance in order to better target resources, time and student interventions. These technologies are helping transform raw data into useful information that teachers and administrators can act upon.

Several states are experimenting with online assessments that provide instant results for students and teachers instead of the long delays between the time of testing and when results are reported that often occur with paper-based assessments. New computer-assisted assessment tools are providing teachers with specific information on where students need help, delivered in a timely manner so teachers can act as soon as possible, and comprehensible enough so that teachers know how to change their practices.

These performance data are fed into robust data warehouses where they are combined with other data, and analyzed to determine what is and is not working. According to the Data Quality Campaign,¹⁰ 36 states have built or are planning to build data warehouses to support their state accountability systems and 47 states have more than half of the essential elements required for robust, longitudinal data systems. But, there is more left to be done. Only 14 states collect student-level college readiness scores, and only 18 states have the ability to match teacher data to student performance.

We believe that student information systems and longitudinal data systems at the school and district levels are critical to the goal of personalizing learning. These data systems also power Web-based services that help parents monitor the performance of their children and schools. For example, on Sept. 9, 2003, President Bush announced the creation of a public-private collaboration between the Broad Foundation and the U.S. Department of Education, to make available important demographic and performance data on every public school in the country. This work was expanded several years later through a new partnership between the Council of Chief State School Officers (CCSSO) and the Bill & Melinda Gates Foundation, which resulted in the Web site www.schoolsdata.org. This site provides a more sophisticated analysis of school performance, resulting in such factors as the “opportunity gap,” which illustrates the differences in achievement between a school and the average of the top comparable schools in the state. Other sites are using Web 2.0 services to help inspire parental involvement with schools. For example, www.greatschools.net allows parents to rate their children’s schools and collaborate with other parents to reform education.

¹⁰ The Data Quality Campaign is a nonprofit organization dedicated to supporting improvement in the collection, availability and use of high-quality education data. It provides tools and resources to encourage state policy makers to implement high-quality state longitudinal data systems as a means to improve student achievement. The campaign works to coordinate efforts among organizations interested in improving data quality, data access and use (<http://www.dataqualitycampaign.org>).

Why It’s Promising: High-quality data is the underpinning for robust accountability systems at the state level and for differentiated instruction inside the classroom. Longitudinal data systems, by following students across grades and schools, help make it possible to determine which programs are working. These same data systems also are needed for more ambitious reforms, such as pay for performance. At a minimum, such tools as online assessments help to identify which students need extra assistance. They also save teachers’ time, and provide them with information that can be acted on immediately versus waiting for the next school year.

In addition, once data are available and flowing within and between K–12 systems, it is possible to create appropriate linkages with higher education institutions by such means as:

- Matching academic records of individual students between K–12 and postsecondary institutions and using these data to ensure continuous feedback and improvement. With two-way data sharing, secondary school officials can know if their students are leaving high school prepared for the demands of postsecondary education, training and work.
- Measuring successful education transitions. As education systems become increasingly aligned through standards, assessments and other measures providing information about whether students are being successful in transitioning between education levels becomes critical. Longitudinal data on student courses and grades, test scores and remediation rates also can serve as college readiness indicators.
- Transferring records across systems and states. In an increasingly mobile world, not only do K–12 education data systems need to be able to exchange information with other systems—such as postsecondary education systems—within the state, but they also need to be able to exchange information with systems in other states.

Next Steps: The federal government has invested \$115 million dollars in helping states improve their data systems and increase their capacity to report their data to the general public and the U.S. Department of Education.¹¹ High-quality data, not just the availability of data, are necessary for accurate decision-making. Just as other industries have benefited from technical standards, from the width of rail beds to the protocols that enabled the Internet, there is a need for a common data standard all across the K–12 data pipeline. Such a standard, the Schools Interoperability Framework (SIF), exists today. Created jointly over the past decade by educators and the private sector, this open, vendor-neutral data standard is already operating in 43 states, and has been proposed by the United Kingdom as its preferred education data transmission strategy.¹² By embracing this standard for education data definition and transmission, it is possible to reduce the cost and increase the efficiency of data sharing and reporting and to improve the quality of the data at the local, state and federal levels. Improved data quality and enhanced data access are the foundation of a truly personalized instructional experience. The states and the federal government can build on the success of state longitudinal data systems by expanding support for the data systems of local education agencies.

¹¹ U.S. Department of Education press releases for the Statewide Longitudinal Data System Grants program, available at <http://www.ed.gov/news/pressreleases/2007/07/07022007a.html> and <http://www.ed.gov/news/pressreleases/2005/11/11182005a.html> (last accessed on Oct. 28, 2008).

¹² Becta, “Statement of intent on interoperability from DCSF, DIUS and Becta,” available at <http://news.becta.org.uk/display.cfm?resID=37481&CFID=1169122&CFTOKEN=6ea1049cac252499-687D240D-AD2D-C487-07E1845EA9F499CA> (Last accessed on Oct. 28, 2008).

Broadband Connectivity

Description: Personalizing learning through the kinds of customized online course delivery and application of data to individualize assessment and accountability systems discussed above requires an increasing reliance on robust networks and high-speed connections to the Internet.

For more than a decade our nation has provided funds to support connecting schools to the Internet through the Schools and Libraries Program of the Universal Service Fund, better known as E-rate. Dedicated to connecting students and teachers to learning tools across the country, E-rate has disbursed over \$14 billion to connect schools, including private schools, and libraries to each other and the public Internet. Each year, about half of E-rate's funds go to help rural and impoverished schools wire their buildings, so that students and teachers can connect to the Internet without leaving the classroom.

In addition to E-rate, the Bush Administration has pursued an aggressive broadband strategy to provide Americans with universal, affordable access to broadband. The Bush Administration led efforts to preserve and make permanent the Internet tax moratorium and to reform the depreciation of assets in order to increase the investments in broadband infrastructure. The National Telecommunications and Information Administration fostered the development of new technologies, such as broadband over power lines and reforms to free up spectrum for advanced wireless services.

As a result of these combined efforts, nearly 100 percent of schools and 94 percent of classrooms are now connected to the Internet.¹³ Since President Bush took office, the total number of broadband lines in the United States has grown by more than 1,100 percent from almost 6.8 million lines in December 2000, to 82.5 million in December 2006, according to the most recent FCC data.¹⁴ Home broadband usage has risen substantially from 9 percent in September 2001 to 51 percent in October 2007.¹⁵ New broadband technologies are being adopted at an even faster pace. For example, the number of broadband lines provided by wireless operators increased from 380,000 in 2005 to almost 22 million at year-end 2006.¹⁶ More than 99 percent of zip code locations have access to at least one broadband provider, over 90 percent have more than three providers and more than 50 percent have six or more choices of broadband providers.¹⁷

Why It's Important: Delivery of services—from data to multimedia content to online sources—requires faster Internet connections capable of supporting large groups of students simultaneously using these cutting-edge innovations. Online assessments have the advantage of instantaneously providing a student's score but require enough bandwidth to handle hundreds of students using the service at a given time. Richer forms of distance education, such as those

¹³ John Wells and Laurie Lewis, *Internet Access in U.S. Public Schools and Classrooms: 1994–2005* (NCES 2007-020). (Washington, D.C.: U.S. Department of Education, National Center for Education Statistics, 2006), p. 4.

¹⁴ National Telecommunications and Information Administration, *Networked Nation: Broadband in America, 2007*. (2008), p. ii.

¹⁵ U.S. Census Bureau, *School Enrollment and Internet Use Supplement to the Current Population Survey* (2007).

¹⁶ National Telecommunications and Information Administration, *Networked Nation: Broadband in America, 2007*. (2008), p. 18.

¹⁷ *Ibid*, p. 14.

provided through videoconferencing, also require stable, robust broadband connections. Broadband at school and home is essential to allowing students to access educational resources 24/7.

Next Steps: The challenge that lies before our education system is to harness the nation's expanding broadband capacity to serve as a robust platform for personalizing instructional delivery. Schools, districts and states should leverage increasing market competition among broadband providers and explore expanding technological delivery models, such as fiber optics and wireless, to develop and expand network capacity to meet the new requirements of online instruction, robust data systems and digital tools used in school.

In these changing times, it is clear that the E-rate program is not keeping pace with the instructional and technology needs of today's schools. The program needs to be changed to respond to future demands. Specifically, the current funding structure needs to be more responsive to education goals and onerous program paperwork requirements need to be reduced or eliminated.

To be more responsive, we must begin by developing a better understanding of the current state of our education sector's digital infrastructure. The FCC and the Department of Education should coordinate in commissioning a study that brings together data from existing sources and initiates an assessment and evaluation of the E-rate program. This evaluation would, for the first time, document the nature and extent of the connectivity and bandwidth capacity of the nation's schools and districts, provide a better understanding of which schools are using the program in what ways and demonstrate the extent to which the program is effective.

The study would answer the following questions to ensure the program is more responsive while minimizing the potential for waste, fraud and abuse:

- How are schools currently using the E-rate program, and which schools are being served?
- How should future E-rate funds be allocated to provide schools the necessary infrastructure to prepare students for the world of tomorrow? Specifically, is the program appropriately focusing on low-income schools?
- How could these funds be better coordinated and matched with other sources of federal, state, local and private funding?
- What performance measures or other demonstrations of successful outcomes might be developed? Specifically, should performance measures be tied to *NCLB* data-reporting requirements, including school improvement plans and student achievement data?
- Can performance measures be linked to increased flexibility in use of E-rate funds?

By examining how E-rate funds are distributed and focusing on what teachers need to meet education objectives, this effort will provide the necessary data and provide a path forward to ensure that the program is used to maximize the education benefits to our 21st-century students.

In addition to these three technical areas, continued effort is also necessary in two areas of broad concern that effect successful technology implementation: research and professional preparation.

Research on Efficacy and Impact

Although we have invested significant resources in technology, we have often failed to rigorously evaluate the impact of those investments. There is much we do not yet know about the ways in which technology can and should be applied to improving teaching and personalizing learning. To build on the scientifically based research at the foundation of *NCLB*, the newly authorized National Center for Research in Advanced Information and Digital Technologies should target research and development that links what we know about how children learn with new technologies, new interfaces and new models of instructional delivery. Foundational research on effectiveness also is required to measure the impact of these federal expenditures and to provide guidance to local communities as they measure their own investments. In order to expand the quality and quantity of research in educational technology, this new center should be tasked with establishing a comprehensive educational technology research agenda to pursue research on the most effective means of implementing technology in education and in evaluating the suitability of emerging technologies for use in K–12 education. This research agenda also should work to expand the role that state and local agencies play as both subjects for and consumers of research findings in educational technology.

School Leadership and Professional Preparation

Finally, none of these efforts at personalizing learning will have any impact without enlightened and effective school leaders, highly effective teachers and providing the opportunity to innovate. But just as jobs in the fields of medicine, finance and industry have changed radically since the turn of the last century, so too must school leadership evolve.

Just as the 21st-century workplace is light years away from the 20th-century factory floor, the information age educational setting that must be created to support improved teaching and personalized learning also must be explored. Unless superintendents, principals and other education administrators are prepared to not only adapt to change, but to lead their schools and systems through the change process, many of our schools will continue to struggle.

Consequently, opportunities should be created for federal, state and local efforts to be joined with those of academia, nonprofit and affinity groups to create new models of leadership that embrace the new practical, technical and pedagogical challenges that face the 21st-century school leader. By working together across disciplines and across governmental levels, new sets of competencies and criteria can be established for these roles and new support structures put in place to assist all school leaders in transforming their education institutions to deliver the personalized instruction necessary to help our children succeed in the 21st century.

CONCLUSION

We have seen our world change around us and now need to retool our education system to respond. Part of our challenge has been that technology has been applied to the outside of the education process, rather than as a critical tool in revamping the process itself. Personalizing instructional delivery through the strategic use of technology is a key part of that transformation.

However, educational technology should not be implemented in a vacuum—it must be tied to the principles of learning and high-quality teaching, all of which must align with challenging content and skill standards. The federal government is a critical but not solitary player in this transformation. Working together with states and localities and inspiring the private and philanthropic sectors we can effect systematic change across the education system from the administrative back office through to the classroom.

Through *NCLB* our nation has been asked to raise our expectations for students. Technology tools can help students meet those expectations and be prepared for the rapidly changing, competitive world they will enter. Throughout our nation's history, we have come together to respond to challenges both foreign and domestic. Our ardent belief in the possibilities of the future and our ability to apply the drive, innovation and invention necessary to realize those possibilities is unique in the world. The decisions we make as a nation about technology in education will have broad implications for our students, not just for classroom performance today, but far into the future. The new global, information economy means new demands and expectations, and we must meet the challenge.



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