OFFICE OF
Educational Technology

Reimagining the Role of Technology in Education:

2017 National Education Technology Plan Update

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Contents

NETP Development

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Letter from the Director

About the 2017 Update

In just one year since the release of the 2016 NETP, we have seen rapid change across the country in fundamental aspects of the educational technology landscape. These changes include the number of schools that that have access to broadband in their classrooms; the types and cost of technology available to schools; an evolution in the approach of leaders to the procurement of ed tech solutions as well as a greater emphasis on data security and digital citizenship; the advent of new research on the use of technology by early learners; and an increased emphasis on preparing teachers to lead with technology *before* they arrive in the classroom.

In order to keep pace with the changes we are seeing in schools, districts, and states on an almost daily basis, we also need to change how often the National Education Technology Plan is updated. Feedback from our stakeholders indicates that the previous five year update cycle was not frequent enough. In response, with this 2017 update, we commence a pattern of yearly, smaller scale updates to the NETP to better account for the pace of innovation in the field.

As part of the 2017 update, the reader will learn that:

- We are encouraged by the fact that most classrooms in our country now have access to broadband, yet we know that many that do not are in communities where the potential impact is the greatest.
- We welcome lower price points for devices designed for school use, but also lament that most ed tech purchases are still based on word of mouth rather than evidence of effectiveness.
- We look forward to a greater emphasis on the use of evidence as outlined within the reauthorization of the Elementary and Secondary Education Act (ESEA), as amended by Every Student Succeeds Act (ESSA), yet recognize that educators will need assistance in expanding their efforts to infuse an evidence-based culture when it comes to ed tech in their schools and classrooms.
- We are pleased to find that, in some districts, librarians and teacher leaders are stepping into more prominent leadership roles that leverage their existing skillsets to lead their peers in pedagogically driven classroom technology use. Yet we also see library positions cut back in other districts as a cost saving measure and the under utilization of classroom teachers as leaders of digital change.
- We are proud of the growing number of students who work with teachers and peers to become responsible digital citizens in their schools, yet recognize that many low-income students, especially in urban and rural areas, lack internet access at home to complete their digital homework assignments and to use powerful digital tools at home to create, to solve, and to communicate that their better-off peers across town take for granted.
- We are eager to take a step forward in understanding and recognizing how the active use of technology by early learners with adults can positively impact them, yet are concerned by the number of children left alone for long periods of time with a passive digital babysitter.

- And we applaud those who are increasing their efforts to prepare pre-service and in-service teachers to use technology in transformative ways for learning. Yet we know that almost half of our teachers desire more training than they currently receive in using technology effectively.

Against this backdrop, it is now more apparent than ever that the courageous efforts of educators to embrace the role of thoughtful, reflective innovators who work collaboratively with each other and alongside their students to explore new learning models, new digital learning environments, and new approaches to working, learning, and sharing is essential if we want technology to be an effective tool to transform learning.

We hope you will take that journey with us!

Joseph South
Director, Office of Educational Technology
US Department of Education

Introduction

One of the most important aspects of technology in education is its ability to level the field of opportunity for students.

—John King, U.S. Secretary of Education

Technology can be a powerful tool for transforming learning. It can help affirm and advance relationships between educators and students, reinvent our approaches to learning and collaboration, shrink long-standing equity and accessibility gaps, and adapt learning experiences to meet the needs of all learners.

Our schools, community colleges, adult learning centers and universities should be incubators of exploration and invention. Educators should be collaborators in learning, seeking new knowledge and constantly acquiring new skills alongside their students. Education leaders should set a vision for creating learning experiences that provide the right tools and supports for all learners to thrive.

However, to realize fully the benefits of technology in our education system and provide authentic learning experiences, educators need to use technology effectively in their practice. Furthermore, education stakeholders should commit to working together to use technology to improve American education. These stakeholders include leaders; teachers, faculty, and other educators; researchers; policymakers; funders; technology developers; community members and organizations; and learners and their families.

The Higher Education Supplement to the NETP — a separate, complementary document — builds on the principles described in each of the NETP's five sections-- learning, teaching, assessment, and infrastructure-- examining them in the context of the higher education ecosystem. It examines the role of technology in serving an increasingly diverse and dispersed student body that is growing and evolving in size and composition and discusses the various ways that technology can enable system- and ecosystem-wide applications of collaborative solutions to systemic issues of access, affordability, and completion.

This 2017 update to the NETP is the first yearly update in the history of the plan. Feedback from the field indicated that the previous five-year update cycle was not frequent enough to account for rapidly changing circumstances and the pace of technology advancement in our schools. It is our intention to continue yearly updates to the NETP.

About This Plan

The National Education Technology Plan (NETP) sets a national vision and plan for learning enabled by technology through building on the work of leading education researchers; district, school, and higher education leaders; classroom teachers; developers; entrepreneurs; and nonprofit organizations. The principles and examples provided in this document align to the Activities to Support the Effective Use of Technology (Title IV) Part A of the ESEA, as amended by ESSA.

THE NETP IS...

a call
to action

a vision for learning
enabled through
technology

a collection
of recommendations
& real-world examples

WRITTEN FOR...

Teachers

Policymakers

Administrators

Teacher preparation
professionals

MAKING POSSIBLE ...

EVERYWHERE, ALL-THE-TIME LEARNING

To illustrate key ideas and recommendations, the plan includes examples of the transformation enabled by the effective use of technology. These examples include both those backed by rigorous evidence as well as emerging innovations. The identification of specific programs or products in these examples is designed to provide a clearer understanding of innovative ideas and is not meant as an endorsement. The NETP also provides actionable recommendations to implement technology and conduct research and development successfully that can advance the effective use of technology to support learning and teaching.

Intended to be useful for any group or individual with a stake in education, the NETP assumes as its primary audiences teachers; education leaders; those responsible for preparing teachers; and policymakers at the federal, state, and local levels. The concepts, recommendations, and examples are also applicable to postsecondary institutions, community organizations, and state-level initiatives. The NETP focuses on using technology to transform learning experiences with the goal of providing greater equity and accessibility (see Section 1: Learning).

When carefully designed and thoughtfully applied, technology can accelerate, amplify, and expand the impact of effective teaching practices. However, to be transformative, educators need to have the knowledge and skills to take full advantage of technology-rich learning environments (see Section 2: Teaching). In addition, the roles of PK–12 classroom teachers and postsecondary instructors, librarians, families, and learners all will need to shift as technology enables new types of learning experiences.

For these systemic changes in learning and teaching to occur, education leaders need to create a shared vision for how technology best can meet the needs of all learners and to develop a plan that translates the vision into action (see Section 3: Leadership).

Technology-enabled assessments support learning and teaching by communicating evidence of learning progress and providing insights to teachers; administrators; families; and, most importantly, the learners themselves. These assessments can be embedded within digital learning[1] activities to reduce interruptions to learning time (see Section 4: Assessment).

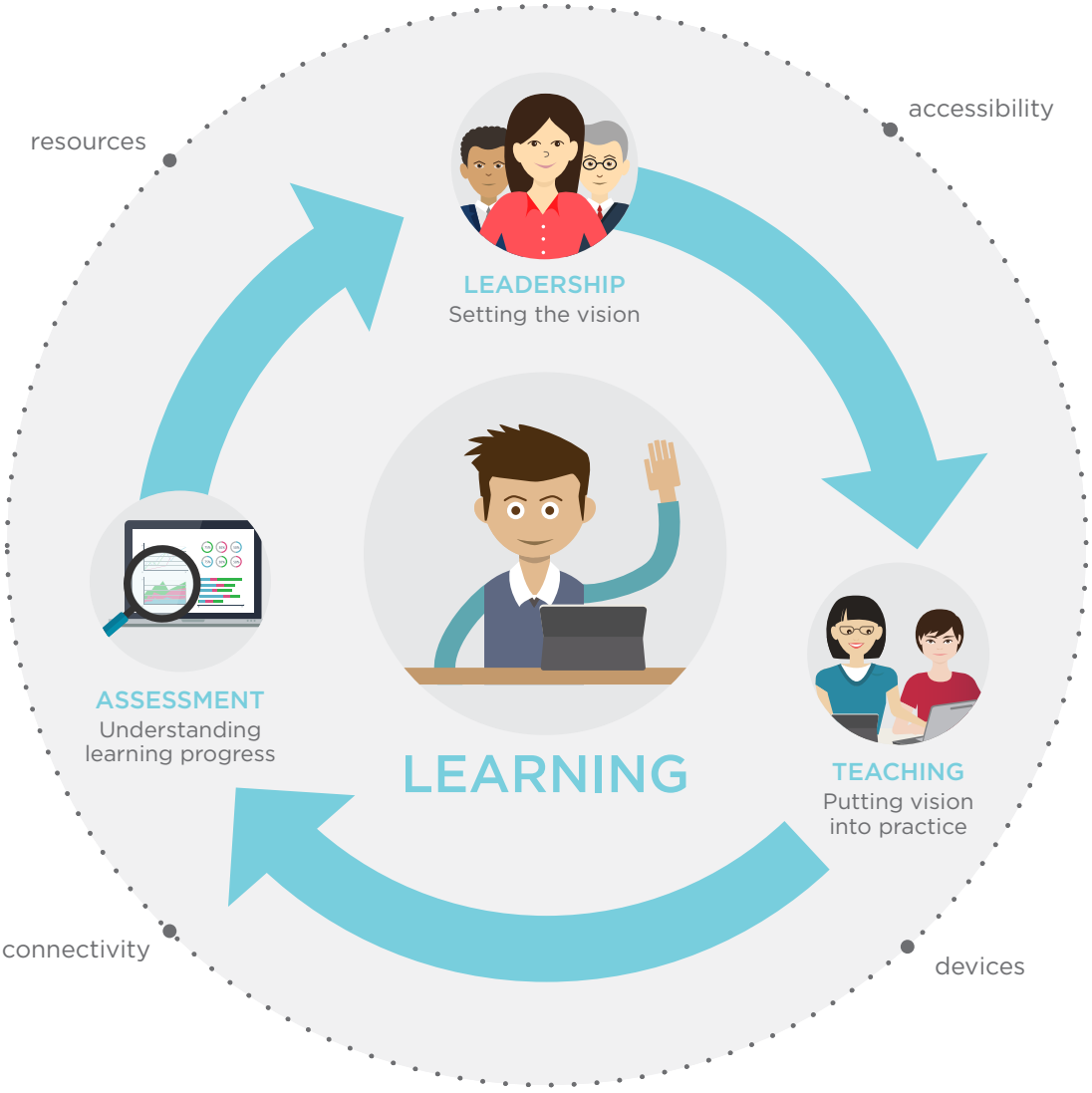
Learning, teaching, and assessment enabled by technology require a robust infrastructure (see Section 5: Infrastructure). Key elements of this infrastructure include high-speed connectivity and devices that are available to teachers and students when they need them. Aside from wires and devices, a comprehensive learning infrastructure includes digital learning content and other resources as well as professional development for educators and education leaders.

EQUITY AND ACCESSIBILITY

Equity in education means increasing all students' access to educational opportunities with a focus on closing achievement gaps and removing barriers that students face based on their race, ethnicity, or national origin; sex; sexual orientation or gender identity or expression; disability; English language ability; religion; socioeconomic status; or geographical location.[2]

Accessibility refers to the design of apps, devices, materials, and environments that support and enable access to content and educational activities for all learners. In addition to enabling students with disabilities to use content and participate in activities, the concepts also apply to accommodating the individual learning needs of students, such as English language learners, students in rural communities, or from economically disadvantaged homes. Technology can support accessibility through embedded assistance, for example, text-to-speech, audio and digital text formats of instructional materials, programs that differentiate instruction, adaptive testing, built-in accommodations, and assistive technology.

FITTING THE PIECES TOGETHER



INFRASTRUCTURE

Providing accessibility, resources and connectivity so that learning is **everywhere, all the time**

Recent Progress and the Road Ahead

Since the 2010 NETP, the U.S. has made significant progress in leveraging technology to transform learning in a variety of ways:

- The conversation has shifted from *whether* technology should be used in learning to how it can improve learning to ensure that all students have access to high-quality educational experiences.[3]
- Technology increasingly is being used to personalize learning and give students more choice over what and how they learn and at what pace, preparing them to organize and direct their own learning for the rest of their lives.
- Advances in the learning sciences have improved our understanding of how people learn and have illuminated which personal and contextual factors most impact their success.
- Research and experience have improved our understanding of what people need to know and the skills and competencies they need to acquire for success in life and work in the 21st century. Through pre-service teacher preparation programs and professional learning, educators are gaining experience and confidence in using technology to achieve learning outcomes.
- Sophisticated software has begun to allow us to adapt assessments and instruction to the needs and abilities of individual learners and provide near real-time results.
- Nationally, significant progress has been made toward ensuring that every school has high-speed classroom connectivity as a foundation for other learning innovations.
- The cost of digital devices has decreased dramatically, while computing power has increased, along with the availability of high-quality interactive educational tools and apps.
- Technology has allowed us to rethink the design of physical learning spaces to accommodate new and expanded relationships among learners, teachers, peers, and mentors.

Although we can be proud of the progress of the last six years, there is still much work to do. Now, a look at the work ahead:

- A digital use divide continues to exist between learners who are using technology in active, creative ways to support their learning and those who predominantly use technology for passive content consumption.
- While school and district leaders often leverage data for decision-making, many still need support and better tools so they can get real-time information on how strategies are working through rigorous, quick-turnaround evaluations of technology.
- Many schools do not yet have access to or are not yet using technology in ways that can improve learning on a daily basis, which underscores the need—guided by new research—to accelerate and scale up adoption of effective approaches and technologies.
- Schools and districts that are deciding how to incorporate educational technology in student learning should actively involve and engage families during early development and implementation of their digital transformation.

DIGITAL USE DIVIDE

Traditionally, the **digital divide** referred to the gap between students who had access to the Internet and devices at school and home and those who did not.[5,6] Significant progress is being made to increase internet access in schools, libraries, and homes across the country. However, a **digital use divide** separates many students who use technology in ways that transform their learning from those who use the tools to complete the same activities but now with an electronic device (e.g., digital worksheets, online multiple-choice tests). The digital use divide is present in both formal and informal learning settings and across high- and low-poverty schools and communities.[7,8,9]

- Few schools have adopted approaches for using technology to support informal learning experiences aligned with formal learning goals.
- Supporting learners in using technology for out-of-school learning experiences is often a missed opportunity.
- Many pre-service teacher education graduates feel unprepared to use technology to support student learning as they transition to teaching and using technology effectively in the classrooms.[4]
- Assessment approaches have evolved but still do not use technology to its full potential to measure a broader range of desired educational outcomes, especially non-cognitive competencies.
- The focus on providing Internet access and devices for learners should not overshadow the importance of preparing teachers to teach effectively with technology and to select engaging and relevant digital learning content.
- As students use technology to support their learning, schools are faced with a growing need to protect student privacy continuously while allowing the appropriate use of data to personalize learning, advance research, and visualize student progress for families and teachers.
- Network security is a growing concern as internet accessible school data, management, and learning systems become more ubiquitous and as the sophistication of attacks on school networks grows, including the use of ransomware.

The NETP is a common vision and action plan that responds to an urgent national priority. It describes specific actions the United States should take to ensure learners of all ages have opportunities for personal growth and prosperity and remain competitive in a global economy.

NON-COGNITIVE COMPETENCIES

Non-cognitive competencies (also referred to as **social and emotional learning**) include a range of skills, habits, and attitudes that facilitate functioning well in school, work, and life. They include self-awareness, self-management, social awareness, and relationship skills as well as perseverance, motivation, and growth mindsets.[10,11,12]

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[1] Digital Learning--, the term "digital learning" has the meaning given the term in section 4102(3) of the ESEA, as amended by ESSA

[2] *U.S. Department of Education, Strategic Plan for Fiscal Years 2014 – 2018*, (2013) http://www2.ed.gov/about/reports/strat/plan2014-18/strategic-plan.pdf.

[3] American Association of School Administrators, Consortium for School Networking, and National School Boards Association. *Leading the digital leap*. Retrieved from http://leaddigitalleap.org.

[4] Retrieved from http://www.cosn.org/sites/default/files/pdf/7%20Keys%20to%20Unlocking%20School%20Transformation%20June13_FNL_HiRes.pdf.

[5] McConnaughey, J. W., Sloan, T., & Nila, C. A. (1995). *Falling through the net: A survey of the "have nots" in rural and urban America*. National Telecommunications and Information Administration, Department of Commerce.

[6] Culp, K. M., Honey, M., & Mandinach, E. (2005). A retrospective on twenty years of education technology policy. *Journal of Educational Computing Research*, 32(3), 279-307.

[7] Warschauer, M. (2012). The digital divide and social inclusion. *Americas Quarterly*, 6(2), 131.

[8] Fishman, B., Dede, C., & Means, B. (in press) Teaching and technology: New tools for new times. *Ann Arbor, 1001*, 48109-1249.

[9] Valadez, J. R., & Durán, R. P. (2007). Redefining the digital divide: Beyond access to computers and the Internet. *The High School Journal*, 90(3), 31-44.

[10] Borghans, L., Duckworth, A. L., Heckman, J. J., & Ter Weel, B. (2008). The economics and psychology of personality traits. *Journal of Human Resources*, 43(4), 972-1059.

[11] Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development*, 82(1), 405-432.

[12] Spitzer, B., & Aronson, J. (2015). Minding and mending the gap: Social psychological interventions to reduce educational disparities. *British Journal of Educational Psychology*, 85(1), 1-18.

1. Learning

Engaging and Empowering Learning Through Technology

GOAL: All learners will have engaging and empowering learning experiences in both formal and informal settings that prepare them to be active, creative, knowledgeable, and ethical participants in our globally connected society.

To be successful in our daily lives and in a global workforce, Americans need pathways to acquire expertise and form meaningful connections to peers and mentors. This journey begins with a base of knowledge and abilities that can be augmented and enhanced throughout our lives. Fortunately, advances in learning sciences have provided new insights into how people learn.[1] Technology can be a powerful tool to reimagine learning experiences on the basis of those insights.

Historically, a learner's educational opportunities have been limited by the resources found within the walls of a school. Technology-enabled learning allows learners to tap resources and expertise anywhere in the world, starting with their own communities. For example:

- With high-speed internet access, a student interested in learning computer science can take the course online in a school that lacks the budget or a faculty member with the appropriate skills to teach the course.
- Learners struggling with planning for college and careers can access high-quality online mentoring and advising programs where resources or geography present challenges to obtaining sufficient face-to-face mentoring.
- With mobile data collection tools and online collaboration platforms, students in a remote geographic area studying local phenomena can collaborate with peers doing similar work anywhere in the world.
- A school with connectivity but without robust science facilities can offer its students virtual chemistry, biology, anatomy, and physics labs—offering students learning experiences that approach those of peers with better resources.
- Students engaged in creative writing, music, or media production can publish their work to a broad global audience regardless of where they go to school.
- Technology-enabled learning environments allow less experienced learners to access and participate in specialized communities of practice, graduating to more complex activities and deeper participation as they gain the experience needed to become expert members of the community.[2]

These opportunities expand growth possibilities for all students while affording historically disadvantaged students greater equity of access to high-quality learning materials, expertise, personalized learning, and tools for planning for future education.[3,4] Such opportunities also can support increased capacity for educators

PERSONALIZED LEARNING

Personalized learning refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. Learning objectives, instructional approaches, and instructional content (and its sequencing) may all vary based on learner needs. In addition, learning activities are meaningful and relevant to learners, driven by their interests, and often self-initiated.

to create blended learning opportunities for their students, rethinking when, where, and how students complete different components of a learning experience.

What People Need to Learn

To remain globally competitive and develop engaged citizens, our schools should weave 21st century competencies and expertise throughout the learning experience. These include the development of critical thinking, complex problem solving, collaboration, and adding multimedia communication into the teaching of traditional academic subjects.[6] In addition, learners should have the opportunity to develop a sense of agency in their learning and the belief that they are capable of succeeding in school.

Beyond these essential core academic competencies, there is a growing body of research on the importance of non-cognitive competencies as they relate to academic success.[7,8,9] Non-cognitive competencies include successful navigation through tasks such as forming relationships and solving everyday problems. They also include development of self-awareness, control of impulsivity, executive function, working cooperatively, and caring about oneself and others.

BUILDING NON-COGNITIVE COMPETENCIES: PROVIDING OPPORTUNITIES FOR PRACTICE

Interacting with peers, handling conflicts, resolving disputes, or persisting through a challenging problem are all experiences that are important to academic success.

Digital games can allow students to try out varied responses and roles and gauge the outcomes without fear of negative consequences.[11] Accumulating evidence suggests that virtual environments and games can help increase empathy, self-awareness, emotional regulation, social awareness, cooperation, and problem solving while decreasing the number of behavior referrals and in-school suspensions.[12]

Games such as Ripple Effects and The Social Express use virtual environments, storytelling, and interactive experiences to assess a student's social skill competencies and provide opportunities to practice. Other apps help bridge the gap between the virtual environment and the real world by providing just-in-time supports for emotional regulation and conflict resolution. A number of apps are available to help students name and identify how they are feeling, express their emotions, and receive targeted suggestions or strategies for self-regulation. Examples include Breathe, Think, Do with Sesame; Smiling Mind; Stop, Breathe & Think; Touch and Learn—Emotions; and Digital Problem Solver.

BLENDED LEARNING[5]

In a **blended learning** environment, learning occurs online and in person augmenting and supporting teacher practice. Blended learning often allows students to have some control over time, place, path, or pace of learning. In many blended learning models, students spend some of their face-to-face time with the teacher in a large group, some face-to-face time with a teacher or tutor in a small group, and some time learning with and from peers. Blended learning often benefits from a reconfiguration of the physical learning space to facilitate learning activities, providing a variety of technology-enabled learning zones optimized for collaboration, informal learning, and individual-focused study.

AGENCY IN LEARNING

Learners with **agency** can "intentionally make things happen by [their] actions," and "agency enables people to play a part in their self-development, adaptation, and self-renewal with changing times."[10] To build this capacity, learners should have the opportunity to make meaningful choices about their learning, and they need practice at doing so effectively. Learners who successfully develop this ability lay the foundation for lifelong, self-directed learning.

FOSTERING GROWTH MINDSET: TECHNOLOGY-BASED PROGRAM TO FUEL STUDENT ACHIEVEMENT

A key part of non-cognitive development is fostering a growth mindset about learning. Growth mindset is the understanding that abilities can be developed through effort and practice and leads to increased motivation and achievement. The U.S. Department of Education has funded several growth mindset–related projects, including a grant to develop and evaluate SchoolKit, a suite of resources developed to teach growth mindset quickly and efficiently in schools.

Jill Balzer, a former middle school principal in Killeen, Texas, has seen success from using SchoolKit in her school. Balzer spoke with an eighth grader who achieved academic distinction for the first time in five years after using the using the program. "When I asked him what the difference was," recalled Balzer, "he said that now he understood that even though learning was not always going to come easy to him it didn't mean he was stupid, it just meant he needed to work harder on that subject."[13]

District of Columbia Public Schools also have made the SchoolKit available to all middle schools. Principal Dawn Clemens of Stuart-Hobson Middle School saw increases in reading scores for their seventh-grade students after using the program. "With middle-schoolers, there are always excuses," Clemens said. "But this shifts the language to be about payoff from effort, rather than 'the test was too hard' or 'the teacher doesn't like me.'"[14]

Increased connectivity also increases the importance of teaching learners how to become responsible digital citizens. We need to guide the development of competencies to use technology in ways that are meaningful, productive, respectful, and safe. For example, helping students learn to use proper online etiquette, recognize how their personal information may be collected and used online, and leverage access to a global community to improve the world around them can help prepare them for successfully navigating life in a connected world. Mastering these skills requires a basic understanding of the technology tools and the ability to make increasingly sound judgments about the use of them in learning and daily life. For the development of digital citizenship, educators can turn to resources such as Common Sense Education's digital citizenship curriculum or the student technology standards from the International Society for Technology in Education (ISTE).

DIGITAL CITIZENSHIP

Digital Citizenship can be defined as the safe, ethical, responsible, and informed use of technology. This concept encompasses a range of skills and literacies that can include internet safety, privacy and security, cyberbullying, online reputation management, communication skills, information literacy, and creative credit and copyright.[15]

Technology-Enabled Learning in Action

Learning principles transcend specific technologies. However, when carefully designed and thoughtfully applied, technology has the potential to accelerate, amplify, and expand the impact of powerful principles of learning. Because the process of learning is not directly observable, the study of learning often produces models and conclusions that evolve across time. The recommendations in this plan are based on current assumptions and theories of how people learn even while education researchers, learning scientists, and educators continue to work toward a deeper understanding.

The NETP focuses on how technology can help learners unlock the power of some of the most potent learning principles discovered to date. For example, we know that technology can help learners think about an idea in more than one way and in more than one context, reflect on what is learned, and adjust understanding accordingly.[16,17] Technology also can help capture learners' attention by tapping into their interests and passions.[18] It can help us align *how* we learn with *what* we learn.

Following are five ways technology can improve and enhance learning, both in formal learning and in informal settings. Each is accompanied by examples of transformational learning in action.

1. **Technology can enable personalized learning or experiences that are more engaging and relevant.** Mindful of the learning objectives, educators might design learning experiences that allow students in a class to choose from a menu of learning experiences—writing essays, producing media, building websites, collaborating with experts across the globe in data collection—assessed via a common rubric to demonstrate their learning. Such technology-enabled learning experiences can be more engaging and relevant to learners.

SCALING UP PERSONALIZED LEARNING: MASSACHUSETTS' INNOVATION SCHOOLS CREATE MULTIPLE PATHWAYS TO LEARNING

As part of Massachusetts' Achievement Gap Act of 2010, funding was set aside to give schools the opportunity to implement innovative strategies to improve learning. Through this legislation, educators can create Innovation Schools that can operate with increased flexibility in key areas such as schedule, curriculum, instruction, and professional development.[19]

As of 2015, there were 54 approved Innovation Schools and Academies in 26 school districts across Massachusetts. Some schools implemented a science, technology, engineering, and mathematics (STEM) or STEM-plus-arts model (STEAM), and others implemented a combination of one or more of the following educational models: multiple pathways, early college, dual-language immersion, or expanded learning time.

Students in a Safety and Public Service Academy combine rigorous college-style coursework available in a variety of formats (in class, online, blended learning, off-site for internships and job shadows) in areas such as forensics, computer science, criminal law, crisis management, psychology, and video production. Students at the Arts Academy may combine their coursework with off-site learning opportunities at local universities, combining high-tech design skills and knowledge of the creative arts to prepare them for postsecondary education and a career in the arts.

Pentucket Regional School District's program has scaled their innovation approach to every elementary school in the district. Their approach is centered on student choice and the use of opportunities for learning that extend beyond the classroom walls. Through the redesign of the school day and year, students engage in hands-on experiential learning with in-class lessons; online and blended coursework; and off-campus academic opportunities, internships, and apprenticeships.

PERCEPTUAL LEARNING MODULES: RESEARCH AND DEVELOPMENT AT THE INTERSECTION OF THE LEARNING SCIENCES AND EDUCATION TECHNOLOGY

Research and development at the intersection of the learning sciences and education technology can lead to innovative products that effectively improve student learning. For example, Perceptual Learning Modules (PLM) software for math, has been developed and tested for efficacy with funding from the Institute of Education Sciences.[20] PLM software is based on decades of research on perceptual learning, which has found that training learners to extract patterns that underlie multiple, variable instances of a concept leads to broader transfer to the classification of new instances of the same concept. When applied to math, the idea is to provide students the opportunity to detect patterns across multiple math problems of the same type rather than simply teaching students the rules and procedures for solving math problems. By looking to the learning sciences, education technology developers can integrate potentially promising, innovative ways to teach new concepts, and can create contexts that maintain students' attention to relevant information, motivation, engagement, all of which are aligned to how people think and learn.

The Early Learning and Educational Technology Policy Brief released jointly with the U.S. Department of Health and Human Services in October 2016 aligns with the Uses of Technology to Support Early Childhood Practice and the National Education Technology Plan (NETP). It supports a vision that 1) all young children will have adults in their lives who are well-informed on how to use technology to support learning at various ages; and 2) all young children will have opportunities to learn, explore, play, and communicate through a multitude of approaches, including the use of technology. The Department of Education provides guidance, with recognition that that technology use should never displace the role of unstructured, unplugged, interactive, and creative play and that these principles may evolve for families and educators in regards to the active use of technology with early learners over time.

EARLY LEARNING AND EDUCATIONAL TECHNOLOGY BRIEF

The Department's' four guiding principles for use of technology with early learners are as follows:

Guiding Principle #1: Technology—when used appropriately—can be a tool for learning.

Guiding Principle #2: Technology should be used to increase access to learning opportunities for all children.

Guiding Principle #3: Technology may be used to strengthen relationships among parents, families, early educators, and young children.

Guiding Principle #4: Technology is more effective for learning when adults and peers interact or co-view with young children.

For more information, educators can read the Early Learning and Education Technology Brief here.

2. **Technology can help organize learning around real-world challenges and** project-based learning **– using a wide variety of digital learning devices and resources to show competency with complex concepts and content.** Rather than writing a research report to be read only by her biology teacher and a small group of classmates, a student might publish her findings online where she receives feedback from researchers and other members of communities of practice around the country. In an attempt to understand the construction of persuasive arguments, another student might draft, produce, and share a public service announcement via online video streaming sites, asking his audience for constructive feedback every step of the way.

PROJECT-BASED LEARNING

Project-based learning takes place in the context of authentic problems, continues over time, and brings in knowledge from many subjects. Project-based learning, if properly implemented and supported, helps students develop 21st century skills including creativity, collaboration, and leadership and engages them in complex, real-world challenges that help them meet expectations for critical thinking.[21]

ENGAGED CREATION: EXPLORATORIUM CREATES A MASSIVE OPEN ONLINE COURSE (MOOC) FOR EXPLORING CIRCUITS AND ELECTRICITY

In the summer of 2015, the Exploratorium in San Francisco launched its first MOOC, working with Coursera, called **Tinkering Fundamentals** to inspire STEM-rich tinkering; introduce a set of high-quality activities that could be replicated easily in the classroom; and foster robust discussions of the learning.

The six-week course included a blend of hands-on activities, short videos of five to eight minutes each, an active discussion forum, live Web chats, social media, and other resources. Each week the videos highlighted an introduction to a new tinkering activity, the learning goals, and tips for facilitation; step-by-step instructions for how to build and support others to build the tinkering contraption; classroom video and interviews with teachers about classroom implementation and student learning; profiles of artists; and comments by learning experts. Reflective prompts generated extensive conversation in the discussion forums.

To facilitate these online activities, the Exploratorium integrated multiple platforms, including Coursera and live video streaming tools. Instructors used these online platforms and spaces to reflect on the week's activities and forum posts and to provide real-time feedback to participants. In videoconferences, the instructors positioned themselves as questioners rather than as experts, enhancing a strong sense of camaraderie and collaborative exploration.

The Exploratorium used a social media aggregator to showcase photos and videos of participants' tinkering creations, underscoring the hands-on and material nature of the work of the MOOC. The course attracted more than 7,000 participants from 150 countries, of whom approximately 4,400 were active participants, resulting in more than 66,000 video views and 6,700 forum posts. For more information, visit the Exploratorium and Coursera on the Web.

BUILDING PROJECTS FOR REAL AUDIENCES: NATIONAL PARKS SERVICE DEEPENS ENGAGEMENT THROUGH TECHNOLOGY

Journey Through Hallowed Ground is a partnership project of the National Park Service that encourages students to create rich connections to history through project-based learning, specifically making videos about their visits to historical sites. The students take the roles of writers, actors, directors, producers, costume designers, music directors, editors, and filmmakers with the support of professional video editors. The videos allow the students to speak about history in their own words as well as share their knowledge with their peers. In addition to learning about history, participating in the projects also teaches students to refine their skills of leadership and teamwork. All videos become official material of the National Park Service and are licensed openly for use by other students and teachers around the world.

3. **Technology can help learning move beyond the classroom and take advantage of learning opportunities available in museums, libraries, and other out-of-school settings.** Coordinated events such as the Global Read Aloud allow classrooms from all over the world to come together through literacy. One book is chosen, and participating classrooms have six weeks in which teachers read the book aloud to students and then connect their classrooms to other participants across the world. Although the book is the same for each student, the interpretation, thoughts, and connections are different. This setting helps support learners through the shared experience of reading and builds a perception of learners as existing within a world of readers. The shared experience of connecting globally to read can lead to deeper understanding of not only the literature but also of their peers with whom students are learning.

UPSKILLING ADULT LEARNERS: AT PEER-TO-PEER UNIVERSITY (P2PU), EVERYONE IS A TEACHER AND A LEARNER

P2PU and the Chicago Public Library (CPL) have partnered to pilot Learning Circles—lightly facilitated study groups for adult learners taking online courses together at their local library. In spring 2015, the partnership ran a pilot program in two CPL branches, facilitating in-person study groups around a number of free, online courses. The pilot program has expanded to 10 CPL branches in fall 2015. As of January 2017, P2PU has met its goal of developing an open-source, off-the-shelf solution that can be deployed by other public libraries, allowing all libraries and their communities to harness the potential of blended learning for little to no expertise or cost.

Meeting once a week in two-hour sessions, a non-content expert librarian helps facilitate a peer-learning environment, with the goal that after six weeks the Learning Circles become self-sustainable. P2PU has designed a number of software tools and guidelines to help onboard learners and facilitators, easing administrative burdens and integrating deeper learning principles into existing online learning content. Initial results suggest that students in Learning Circles have far higher retention than do students in most online courses, participants acquire non-cognitive skills often absent from pure online learning environments, and a diverse audience is participating. By working with libraries and building in additional learning support, P2PU also is able to reach first-time online learners, many of whom do not have a postsecondary degree..

P2PU measures success in terms of both the progress of individual learners and the viability of the model. In addition to the number of branches involved, cost per user, and number of learners, attributes such as retention, returning to additional Learning Circles,

advancing from the role of learner to that of facilitator, and transitioning from Learning Circles into other fields (formal education, new job) are all other factors that contribute to success. Furthermore, P2PU designs for and measures academic mindsets (community, self-efficacy, growth mindsets, relevance) as a proxy for learner success.

HELPING PARENTS NAVIGATE A TECHNOLOGICAL WORLD: A RESOURCE FOR MAKING INFORMED TECHNOLOGY DECISIONS

Family Time With Apps: A Guide to Using Apps With Your Kids is an interactive resource for parents seeking to select and use apps in the most effective ways with their children.[22] The guide informs parents of the variety of ways that apps can support children's healthy development and family learning, communication, and connection with eight strategies. These strategies are playing games together, reading together every day, creating media projects, preparing for new experiences, connecting with distant family, exploring the outside world, making travel more fun, and creating a predictable routine. Tips on how to find the best apps to meet a child's particular needs and an explanation of how and why to use apps together also are included.

The guide references specific apps, which connect parents with the resources to select appropriate apps for their children. This online community is connected with various app stores and gives parents a menu for app selection on the basis of learning topic, age, connectivity, and device capability. Information also is included that describes exactly what other elements are attached to each app—for example, privacy settings, information collection, advertisements allowed, related apps, and so on.

The Joan Ganz Cooney Center at Sesame Workshop also recommends the Parents' Choice Award Winners as a tool for selecting child-appropriate apps. These apps, reviewed by the Parents' Choice Awards Committee within the Parents' Choice Foundation, have gone through a rigorous, multi-tiered evaluation process. The committee looks for apps that help children grow socially, intellectually, emotionally, and ethically while inspiring creativity and imagination and connecting parents and children.

4. **Technology can help learners pursue passions and personal interests.** A student who learns Spanish to read the works of Gabriel García Márquez in the original language and a student who collects data and creates visualizations of wind patterns in the San Francisco Bay in anticipation of a sailing trip are learning skills that are of unique interest to them. This ability to learn topics of personal interest teaches students to practice exploration and research that can help instill a mindset of lifelong learning.

LEVERAGING THE POWER OF NETWORKS: CULTIVATING CONNECTIONS BETWEEN SCHOOLS AND COMMUNITY INSTITUTIONS

Cities of LRNG helps close the opportunity gap by connecting young people with a wide range of learning opportunities throughout their cities. After three years of continuous development, the project has expanded to more than ten cities including Philadelphia, Washington, D.C. and Chicago. Cities of LRNG focus on the network of learning opportunities available in the nation's cities – at school, at creative camps and classes, science museums, and through workplace internships. Students using the LRNG platform are connected to a larger learning ecosystem and given access to opportunities.

The LRNG platform is designed with the goal of creating tools that transform how young people recognize and access opportunities for learning. In March 2016, eight

cities were awarded a grant up to $50,000 to begin developing their own LRNG ecosystem. In Kansas City, MO, one of the newest LRNG cities, youth can access the LRNG platform and have the ability to earn badges that signify mastery of a skill – for example, coding, games, design, or even fashion. Students who earn badges can use these credentials when applying for the city's summer youth internship and employment program.

Hive Learning Networks, a project of the Mozilla Foundation, organize and support city-based, peer-to-peer professional development networks and champion connected learning, digital skills, and Web literacy in youth-serving organizations in urban centers around the world. Using a laboratory approach and catalytic funding model, Hive re-imagines learning as interest based and empowers learners through collaboration with peer educators, youth, technology experts, and entrepreneurs.

Similar to Cities of LRNG, Hive networks are made up of community-based organizations, including libraries; museums; schools; after-school programs; and individuals, such as educators, designers, and artists. Hive participants work together to create learning opportunities for youth within and beyond the confines of traditional classroom experiences, design innovative practices and tools that leverage digital literacy skills for greater impact, and advance their own professional development.

The Hive model supports three levels of engagement:

1. **Events.** Organizations with shared learning goals unite to provide fun, engaging events, such as maker parties, as a first step toward exploring longer-term collaborations.
2. **Learning Communities.** Community organizers with an interest in Hive's core principles come together in regular meetups and events to explore how to apply connected learning tools and practices. Learning communities are in seven cities in the United States, Canada, and India.
3. **Learning Networks.** With an operational budget and staff, Hive Learning Networks commit to promoting innovative, open-source learning models in partnership with a community's civic and cultural organizations, businesses, entrepreneurs, educators, and learners. Learning Networks are in New York, Chicago, and Pittsburgh.

For more information about Hive Learning Networks, visit Hive on the Web.

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5. **Technology access when equitable can help close the digital divide and make transformative learning opportunities available to all learners.** An adult learner with limited physical access to continuing education can upskill by taking advantage of online programs to earn new certifications and can accomplish these goals regardless of location.

BUILDING EQUAL EXPERIENCES: BLACK GIRLS CODE (BGC) INFORMS AND INSPIRES

Introducing girls of color to technology at an early age is one key to unlocking opportunities that mostly have eluded this underserved group. BGC, founded in 2001 by Kimberly Bryant, an electrical engineer, aims to "increase the number of women of color in the digital space by empowering girls of color to become innovators in STEM subjects, leaders in their communities, and builders of their own futures through exposure to computer science and technology."[23]

Through a combination of workshops and field trips, BGC gives girls of color a chance to learn computer programming and connects them to role models in the technology

space. BGC also hosts events and workshops across the country designed to help girls develop a wide range of other skills such as ideation, teamwork, and presenting while exploring social justice issues and engaging in creating solutions to those issues through technology.[24] One example of such an event occurred at the Florida Vocational Institute[25] where girls between the ages of 7 and 17 learned animation and game design concepts using programs such as SCRATCH, a free educational programming language developed by the Lifelong Kindergarten Group at the Massachusetts Institute of Technology that is made available to all.[26] Tech industry volunteers led sessions in mobile app design, robotics, and game development. The day included a career panel for young girls and their parents. Since the program's conception in 2011, more than 5000 young girls have participated in BCG workshops.

BCG is headquartered in San Francisco, and BCG chapters are located in Atlanta, Boston, Chicago, Dallas, Detroit, Memphis, Miami, New York, Oakland, Raleigh, Johannesburg, South Africa, and Washington, D.C.

CREATING FOR ACCESS: HELLO NAVI FOR THE VISUALLY IMPAIRED

When Maggie Bolado, a teacher at Resaca Middle School in Los Fresnos, Texas, was approached about the unique challenge of helping a visually impaired student navigate the school's campus, she had not imagined the innovation that was about to happen. Bolado helped guide a group of seventh- and eighth-grade students to develop an app to navigate the school grounds called Hello Navi. Working mostly during extracurricular time, the students learned bracket coding via online tutorials that enabled them to develop the app. As they learned to program, they also were developing problem-solving skills and becoming more detail oriented.

When the app was made available for download, requests came in to tailor the app to the needs of other particular users, including one parent who wanted to know how to make it work for her two-year-old child. The students participated in a developers' forum to go through requests and questions on the app and problem-solve challenges and issues together. The students also interpreted various data sets, tracking the number of times the app was downloaded and monitoring the number of total potential users, making possible an improved next iteration of the app.

The Future of Learning Technologies

Although these examples help provide understanding of the current state of educational technologies, it is also important to note the research being done on early stage educational technology and how this research might be applied more widely in the future to learning.

As part of their work in cyberlearning, the National Science Foundation (NSF) is researching opportunities offered by integrating emerging technologies with advances in the learning sciences. Following are examples of the projects being funded by the NSF as part of this effort:

In K-12 classrooms across the United States, students are visiting far off places such as Machu Picchu, the Great Barrier Reef, and other locations without ever leaving the classroom. Educators can access programs such as the Google Expedition Pioneer Program for lessons and additional resources to create virtual field trip experiences. Students can then use Google Cardboard—an inexpensive pair of VR goggles made from a cardboard cutout,

magnets, lens and a user-supplied smartphone—to move through an experience that their teacher controls from a tablet. The I-CorpsTM L project, a program within the National Science Foundation, is currently piloting a similar project for higher education settings. This Virtual Reality Field Experiences (VRFE) application uses an Android smartphone with an accompanying virtual reality viewer such as Google Cardboard.

Through the Virtual Learning Labs Research and Development Center awarded by IES in 2016, researchers at the University of Florida are studying how education technology systems can use large amounts of data to effectively adapt instruction for students. The Center is using data from prior students to personalize Algebra Nation, a free online learning platform for students and teachers. Goals for this effort include promoting mastery of basic algebra; developing indicators of engagement during learning; designing professional development to help teachers use learning analytics to differentiate instruction; and engaging in leadership and outreach around the design of personalization of virtual learning systems through the use of learning analytics and accompanying professional development for teachers.

Increased use of games and simulations to give students the experience of working together on a project without leaving their classrooms. Students are involved actively in a situation that feels urgent and must decide what to measure and how to analyze data in order to solve a challenging problem. Examples include RoomQuake, in which an entire classroom becomes a scaled-down simulation of an earthquake. As speakers play the sounds of an earthquake, the students can take readings on simulated seismographs at different locations in the room, inspect an emerging fault line, and stretch twine to identify the epicenter. Another example is Robot-Assisted Language Learning in Education (RALL-E), in which students learning Mandarin converse with a robot that exhibits a range of facial expressions and gestures, coupled with language dialogue software. Such robots will allow students to engage in a social role-playing experience with a new language without the usual anxieties of speaking a new language. The RALL-E also encourages cultural awareness while encouraging good use of language skills and building student confidence through practice.

New ways to connect physical and virtual interaction with learning technologies that bridge the tangible and the abstract. For example, the In Touch With Molecules project has students manipulate a physical ball-and-stick model of a molecule such as hemoglobin, while a camera senses the model and visualizes it with related scientific phenomena, such as the energy field around the molecule. Students' tangible engagement with a physical model is connected to more abstract, conceptual models, supporting students' growth of understanding. Toward a similar goal, elementary school students sketch pictures of mathematical situations by using a pen on a tablet surface with representational tools and freehand sketching, much as they would on paper. Unlike with paper, they easily copy, move, group, and transform their pictures and representations in ways that help them to express what they are learning about mathematics. These can be shared with the teacher, and, via artificial intelligence, the computer can help the teacher see patterns in the sketches and support the teacher's using student expression as a powerful instructional resource.

Interactive three-dimensional imaging software, such as zSpace, is creating potentially transformational learning experiences. With three-dimensional glasses and a stylus, students are able to work with a wide range of images from the layers of the earth to the human heart. The zSpace program's noble failure feature allows students constructing a motor or building a battery to make mistakes and retry, learning throughout the process. Although the content and curriculum are supplied, teachers can customize and tailor lesson plans to fit the needs

of their classes. This type of versatile technology allows students to work with objects schools typically would not be able to afford, providing a richer, more engaging learning experience.

Augmented reality (AR) as a new way of investigating our context and history In the Cyberlearning: Transforming Education EXP project, researchers are addressing how and for what purposes AR technologies can be used to support the learning of critical inquiry strategies and processes. The question is being explored in the context of history education and the Summarizing, Contextualizing, Inferring, Monitoring, and Corroborating (SCIM-C) framework developed for historical inquiry education. A combined hardware and software platform is being built to support SCIM-C pedagogy. Students use a mobile device with AR to augment their "field" experience at a local historical site. In addition to experiencing the site as it exists, AR technology allows students to view and experience the site from several social perspectives and to view its structure and uses across several time periods. Research focuses on the potential of AR technology in inquiry-based fieldwork for disciplines in which analysis of change across time is important to promote understanding of how very small changes across long periods of time may add up to very large changes.

Across these examples, we see that learning is not contained within screens or classrooms and that technology can enrich how students engage in the world around them.

To see additional examples of cyberlearning, visit The Center for Innovative Research in CyberLearning.[27]

Bringing Equity to Learning Through Technology

Closing the Digital Use Divide

Traditionally, the digital divide in education referred to schools and communities in which access to devices and Internet connectivity were either unavailable or unaffordable.[28] Although there is still much work to be done, great progress has been made providing connectivity and device access. The modernization of the federal E-rate program has made billions of dollars available to provide high-speed wireless access in schools across the country.

However, we have to be cognizant of a new digital divide—the disparity between students who use technology to create, design, build, explore, and collaborate and those who simply use technology to consume media passively.[29,30,31,32] On its own, access to connectivity and devices does not guarantee access to engaging educational experiences or a quality education.[33] Without thoughtful intervention and attention to the way technology is used for learning, the digital use divide could grow even as access to technology in schools increases.[34,35,36,37]

E-RATE: SOURCE OF FUNDING FOR CONNECTIVITY

The Schools and Libraries Universal Service Support Program, commonly known as **E-rate**, is a source of federal funding for Internet connectivity for U.S. schools and libraries. Created by Congress in 1996, E-rate provides schools and libraries with discounted Internet service based on need. The program was modernized in 2014 to allow schools to prioritize funding high-speed wireless connectivity in schools. For more information about E-rate, visit the website of the Federal Communications Commission (FCC)..

DIGITAL USE DIVIDE

While essential, closing the digital divide alone will not transform learning. We must also close the digital **use** divide by ensuring all students understand how to use technology as a tool to engage in creative, productive, life-long learning rather than simply consuming passive content.

PASSIVE USE

ACTIVE USE

Providing Technology Accessibility for All Learners

Learning experiences enabled by technology should be accessible for all learners, including those with special needs. Supports to make learning accessible should be built into learning software and hardware by default. The approach of including accessibility features from the beginning of the development process, also known as *universal design*, is a concept well established in the field of architecture. Modern public buildings include features such as ramps, automatic doors, or braille on signs to make them accessible by everyone. In the same way, features such as text-to-speech, speech-to-text, enlarged font sizes, color contrast, dictionaries, and glossaries should be built into educational hardware and software to make learning accessible to everyone.

Three main principles drive application of universal design for learning (UDL):[38,39,40,41]

1. **Provide multiple means of representation so that students can approach information in more than one way.** Examples include digital books, specialized software and websites, and screen readers that include features such as text-to-speech, changeable color contrast, alterable text size, selection of different reading levels or materials written in the learner's primary language.
2. **Provide multiple means of expression so that all students can demonstrate and express what they know.** Examples include providing options in how they express their learning, where appropriate, which can include options such as writing, online concept mapping, speech-to-text or translation programs.

3. **Provide multiple means of engagement to stimulate interest in and motivation for learning.** Examples include providing options among several different learning activities or content for a particular competency or skill, providing opportunities for increased collaboration or scaffolding, or providing tools, such as digital storytelling, to ensure grade-appropriate content material is accessible to many learners.

Digital learning tools can offer more flexibility and learning supports than can traditional formats. Using mobile devices, laptops, and networked systems, educators are better able to personalize and customize learning experiences to align with the needs of each student. They also can expand communication with mentors, peers, and colleagues through social media tools. Digital tools also can make it possible to modify content, such as raising or lowering the complexity level of a text or changing the presentation rate.

At a higher level of engagement, digital tools such as games, websites, and digital books can be designed to meet the needs of a range of learners, from novices to experts. Learners with little understanding might approach the experience first as a novice and then move up to an intermediate level as they gain more knowledge and skills. One example is McGill University's The Brain from Top to Bottom. The site includes options to engage with the content as a beginner, intermediate, or advanced learner and adjusts the learning activities accordingly.

To help in the selection of appropriate universally designed products and tools, the National Center on Universal Design for Learning has developed a resource linking each guideline to information about digital supports that can help a teacher put UDL into practice.

REACHING ALL LEARNERS: TOOLS FOR UDL

Developed with support from the U.S. Department of Education, the tools listed here were designed to help educators implement UDL principles into classroom practice and make learning activities more accessible:

- The Information Research Corporation developed eTouchSciences, an integrated software and hardware assistive technology platform to support STEM learning among middle school students with (or without) visual impairments. The product includes a haptic sensing controller device to provide real-time tactile, visual, and audio feedback. See video.
- Filament Games developed the Game-enhanced Interactive Life Science suite of learning games to introduce middle school students to key scientific concepts and practices in the life sciences. These games, aligned to UDL, provide students with multiple means of representation, expression, and engagement and provide assistive features such as in-game glossaries and optional voice-over for all in-game text. See video.
- Institute for Disabilities Research and Training developed the myASL Quizmaker to provide Web-based assessments for deaf or hard of hearing students who use ASL. This product provides automatic ASL graphic and video translations for students; enables teachers to create customized tests, exams, and quizzes that are scored automatically; and provides teacher reports with grades and corrected quizzes. See video.

- Benetech, with the support of the U.S. Department of Education's Office of Special Education Programs, built the DIAGRAM Center. The DIAGRAM Center is a research and development center whose goal is to dramatically change the way digital content for Accessible Educational Materials is produced and accessed, so that students with disabilities have meaningful access to the general education curriculum and to STEM materials in particular. This work has included descriptive image and video technology, technical standards development, and efforts to grow the community around "born accessible" resources and technologies.

DESIGN IN PRACTICE: INDIANA SCHOOL DISTRICT ADOPTS UDL FOR ALL INSTRUCTION FOR ALL STUDENTS

Bartholomew Consolidated School Corporation is a public school district in Columbus, Indiana, serving approximately 12,000 students. In 2016 the student population consists of 12 percent in special education, 43 percent receive free or reduced-price lunch, and more than 54 languages are spoken. UDL has been helpful as a decision-making tool in the deployment of technologies such as computers and other networked devices. The UDL guidelines help educators determine what strategies, accessible technologies, and teaching methods will enable all students to achieve lesson goals.

In one instance, a social studies teacher held an online discussion during a presidential debate. Realizing that some students were not taking part in class discussions, the teacher used technology to provide multiple means of representation, expression, and engagement. Some students who were reluctant to speak up in a face-to-face setting felt safe to do so online, becoming engaged participants in the class discussion.

Since they adopted a universal design approach, graduation rates increased by 8 percent for general education students and 22 percent for special education students. Also, the number of students taking and passing Advanced Placement tests has increased.

Physical Spaces and Technology-Enabled Learning

Blended learning and other models of learning enabled by technology require educators to rethink how they organize physical spaces to facilitate best collaborative learning using digital tools. Considerations include the following:

- Are the design and layout of the physical space dynamic and flexible enough to facilitate the technology-enabled learning models and practices selected? Can a space in which an educator delivers whole-class instruction also be shifted to facilitate individual online practice and research?
- Do the physical spaces align in their ability to facilitate individual and collaborative work? When practices such as project-based learning require students to be working together with multiple devices for research and presentation building, is the space as useful as when individual learners need time and space to connect with information and experts online for personalized learning?
- Can the physical spaces and tools be shaped to provide multiple contexts and learning experiences such as Wi-Fi access for outdoor classrooms? Are library spaces able to become laboratories? Can a space used as a history lecture hall for one class become a maker space for engineering the next period?

For more information and tools for aligning physical spaces, visit the Center for Effective Learning Environments and the Clayton Christensen Institute's Blended Learning Universe.

INNOVATION FROM THE GROUND UP: DENVER SCHOOL FOR SCIENCE AND TECHNOLOGY (DSST) USES SPACE TO PROMOTE STUDENT ACHIEVEMENT

The DSST is an innovative high school located in Stapleton, Colorado, a redeveloped neighborhood near downtown Denver. Behind the bright colors and unique geometry of spaces at DSST lies a relationship to the way academic subjects are taught and community is formed at the high school. The school is designed to be flexible and aims to support student achievement through the design of its physical spaces.

The school features a series of gathering spaces that can be used for various academic and social purposes throughout the day. The largest of the gathering areas, near the school's entrance, is where the school's daily morning meeting for both students and faculty is held. Student and faculty announcements, skits, and other community functions are all encouraged in this communal setting.

Each of the three academic pods also includes informal spaces for gathering, studying, and socializing. These academic clusters are linked by a galleria, or large open hallway, that is lined with skylights and also serves as a gathering place for students and faculty members.

DSST has demonstrated results in the academic achievement of its students and in its attendance record. In 2005, the school's founding Grade 9 class was the highest scoring Grade 9 class in Denver in mathematics and the second highest scoring class in reading and writing. DSST was also the only Denver high school to earn a significant growth rating on the Colorado Student Assessment Program test scores from one year to the next. Student attendance at the school is typically about 96 percent.

ALIGN, DESIGN, PILOT: RETHINKING LEARNING SPACES IN EANES INDEPENDENT SCHOOL DISTRICT (ISD)

In 2015, Eanes ISD's Westlake High School in Austin, Texas, embarked on a project to reimagine their learning spaces. Before purchasing furniture, their first step was to start with their district mission statement and goals for student learning. A committee of teachers, librarians, administrators, and students developed a list of design drivers for the changes they wished to see. "As a school, our mission was not just to change classroom furniture, but to impact teaching and learning in our classrooms," says district and high school librarian Carolyn Foote. "We wanted these changes to coincide with the reboot of our 1:1 iPad initiative, so we could amplify the benefits of mobile technology by making classroom environments more mobile as well. In order to do that, we had to be focused on our goals for learning." In previous years, the library had redesigned their computer lab to create a more flexible learning space, so it was a natural fit that as lead librarian, Foote was able to leverage her expertise from those projects to also lead the classroom makeover pilot.

In the fall of 2015, teachers applied to be part of the classroom remodel pilot, and attend required professional development. Students and teachers were invited to share input, ultimately resulting in four prototype classroom types. Designs included mobile teacher stations, mobile student chairs, personal whiteboards, soft seating and more. Before and after surveys of students and faculty were conducted to identify if the pilot was impacting student experience positively and librarian Carolyn Foote and campus instructional partner Valerie Taylor organized and supported the entire grass-roots implementation.

In post surveys, teachers and students alike reported that their classrooms were more agile, that they were more willing to try something new curricularly,and that collaboration increased in the new classroom design. Positive feedback about classroom environment and comfort also supported the district's Social Emotional Learning goals.

With the knowledge gained from teachers and students, the district is expanding the pilot to include model classrooms on all campuses and then expanding the high school pilot as well. "We want all of our classrooms to better physically reflect the changes that mobile technologies have brought to our 1:1 district." Expanding her role, Foote will work with elementary and middle school committees to formulate and finalize designs for their pilots as well, moving forward in 2017.

Recommendations

- **States, districts, and postsecondary institutions should develop and implement learning resources that embody the flexibility and power of technology to create equitable and accessible learning ecosystems that make learning possible everywhere and all the time for all students.**
  Whether creating learning resources internally, drawing on collaborative networks, or using traditional procurement procedures, institutions should insist on the use of resources and the design of learning experiences that use UD practices to ensure accessibility and increased equity of learning opportunities.
- **States, districts, and postsecondary institutions should develop and implement learning resources that use technology to embody design principles from the learning sciences.**
  Educational systems have access to cutting-edge learning sciences research. To make better use of the existing body of research literature, however, educators and researchers will need to work together to determine the most useful dissemination methods for easy incorporation and synthesis of research findings into teachers' instructional practices.
- **States, districts, and postsecondary institutions should take inventory of and align all learning technology resources to intended educational outcomes. Using this inventory, they should document all possible learner pathways to expertise, such as combinations of formal and informal learning, blended learning, and distance learning.**
  Without thoughtful accounting of the available tools and resources within formal and informal learning spaces within a community, matching learners to high-quality pathways to expertise is left to chance. Such an undertaking will require increased capacity within organizations that have never considered such a mapping of educational pathways. To aid in these efforts, networks such as LRNG, the Hive Learning Networks, and education innovation clusters can serve as models for cross-stakeholder collaboration in the interest of best practices for using existing resources to present learners with pathways to learning and expertise.
- **Education stakeholders should develop a born accessible standard of learning resource design to help educators select and evaluate learning resources for accessibility and equity of learning experience.**
  Born accessible is a play on the term born digital and is used to convey the idea that materials that are born digital also can and should be born accessible. If producers adopt current industry standards for producing educational materials, materials will be accessible out of the box. Using the principles and research-base of UD and UDL, this standard would serve as a commonly accepted framework and language around design for accessibility and offer guidance to vendors and third-party technology developers in interactions with states, districts, and institutions of higher education.
- **More research is needed on how the learning sciences – the scientific study of how people learn – can inform how technology is developed and used in school settings.**
  Researchers in this field address research questions such as how to optimally present information to students, what study strategies lead to optimal retention of information, and what and

how content should be taught. Foundational knowledge about how people learn can be used to design more effective education technology products that align to how the mind works. Hirsh-Pasek, et al., for example, propose a learning sciences framework for identifying potentially effective educational apps based on four factors: active, engaged, meaningful, and socially interactive learning. Similar frameworks could be developed to guide the development and identification of other types of effective education technology products.[42]

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2. Teaching

Teaching With Technology

GOAL: Educators will be supported by technology that connects them to people, data, content, resources, expertise, and learning experiences that can empower and inspire them to provide more effective teaching for all learners.

Technology offers the opportunity for teachers to become more collaborative and extend learning beyond the classroom. Educators can create learning communities composed of students; fellow educators in schools, museums, libraries, and after-school programs; experts in various disciplines around the world; members of community organizations; and families. This enhanced collaboration, enabled by technology offers access to instructional materials as well as the resources and tools to create, manage, and assess their quality and usefulness

To enact this vision, schools need to support teachers in accessing needed technology and in learning how to use it effectively. Although research indicates that teachers have the biggest impact on student learning out of all other school-level factors, we cannot expect individual educators to assume full responsibility for bringing technology-based learning experiences into schools.[1,2,3,4,5] They need continuous, just-in-time support that includes professional development, mentors, and informal collaborations. In fact, more than two thirds of teachers say they would like more technology in their classrooms,[6] and roughly half say that lack of training is one of the biggest barriers to incorporating technology into their teaching.[7]

Institutions responsible for pre-service and in-service professional development for educators should focus explicitly on ensuring all educators are capable of selecting, evaluating, and using appropriate technologies and resources to create experiences that advance student engagement and learning. They also should pay special care to make certain that educators understand the privacy and security concerns associated with technology. This goal cannot be achieved without incorporating technology-based learning into the programs themselves.

For many teacher preparation institutions, state offices of education, and school districts, the transition to technology-enabled preparation and professional development will entail rethinking instructional approaches and techniques, tools, and the skills and expertise of educators who teach in these programs. This rethinking should be based on a deep understanding of the roles and practices of educators in environments in which learning is supported by technology.

Roles and Practices of Educators in Technology-Supported Learning

Technology can empower educators to become co-learners with their students by building new experiences for deeper exploration of content. This enhanced learning experience embodies John Dewey's notion of creating "more mature learners."[8] Side-by-side, students and teachers can become engineers of collaboration, designers of learning experiences, leaders, guides, and

catalysts of change.[9,10] Following are some descriptions of these educator roles and examples of how technology can play an integral part.

Educators can collaborate far beyond the walls of their schools. Through technology, educators are no longer restricted to collaborating only with other educators in their schools. They now can connect with other educators and experts across their communities or around the world to expand their perspectives and create opportunities for student learning. They can connect with community organizations specializing in real-world concerns to design learning experiences that allow students to explore local needs and priorities. All of these elements make classroom learning more relevant and authentic.

In addition, by using tools such as videoconferencing, online chats, and social media sites, educators, from large urban to small rural districts, can connect and collaborate with experts and peers from around the world to form online professional learning communities.

AUTHENTIC LEARNING
Authentic learning experiences are those that place learners in the context of real-world experiences and challenges.[11]

BUILDING COMMUNITIES FOR EDUCATORS: INTERNATIONAL EDUCATION AND RESOURCE NETWORK (iEARN) FOSTERS GLOBAL COLLABORATIVE TEACHING AND LEARNING

Through technology, educators can create global communities of practice that enable their students to collaborate with students around the world. Technology enables collaborative teaching regardless of geographic location, as demonstrated by the global nature of the Solar Cooking Project organized by earth and environmental science teacher Kathy Bosiak.

Bosiak teaches at Lincolnton High School in Lincolnton, North Carolina, and is a contributing educator for iEARN, a nonprofit organization made up of more than 30,000 schools and youth organizations in more than 140 countries. iEARN offers technology-enabled resources and face-to-face workshops for educators that enable teachers and students around the world to collaborate on educational projects.[12]

As of January 2017, iEARN has reached over 2,000,000 students and 50,000 educators who are deepening their global citizen engagement through international virtual networks. By participating in these global communities of practice, educators are learning with the world, not just about it.

Educators can design highly engaging and relevant learning experiences through technology. Educators have nearly limitless opportunities to select and apply technology in ways that connect with the interests of their students and achieve their learning goals. For example, a classroom teacher beginning a new unit on fractions might choose to have his students play a learning game such as Conceptua Math, Factor Samurai, Wuzzit Trouble, or Sushi Monster as a way to introduce the concept. Later, the teacher might direct students to practice the concept by using manipulatives so they can start to develop some grounded ideas about equivalence.[13]

To create an engaging and relevant lesson that requires students to use content knowledge and critical thinking skills, an educator might ask students to solve a community problem by using technology. Students may create an online community forum, public presentation, or call to action related to their proposed solution. They can use social networking platforms to gather information and suggestions of resources from their contacts. Students can draft and present their work by using animated presentation software or through multimedia formats such as videos and blogs. This work can be shared in virtual discussions with content experts and stored in online learning portfolios.

A school without access to science labs or equipment can use virtual simulations to offer learners those experiences that are currently unavailable because of limited resources. In addition, these simulations are safe places for students to learn and practice effective processes before they conduct research in the field. Just as technology can enhance science learning for schools lacking equipment, it can enable deep learning once students are in the field as well. Students can collect data for their own use via mobile devices and probes and sync their findings with those of collaborators and researchers anywhere in the world to create large, authentic data sets for study.

Educators can lead the evaluation and implementations of new technologies for learning. Lower price points for learning technologies make it easier for educators to pilot new technologies and approaches before attempting a school-wide adoption. These educators also can lead and model practices around evaluating new tools for privacy and security risks, as well as compliance with federal privacy regulations. (For more on these regulations, see Section 5: Infrastructure). Teacher-leaders with a broad understanding of their own educational technology needs, as well as those of students and colleagues, can pilot the chosen technology with a small number of students to quickly and rigorously assess the implementation of approach and whether the technology delivers the desired outcomes. This allows schools to gain experience with and confidence in these technologies before committing entire schools or districts to purchases and use.

Teacher-leaders and those with experience supporting learning with technology can work with administrators to determine how to share their learning with other teachers. They also can provide support to their peers by answering questions and modeling practical uses of technology to support learning.

EVALUATING TECHNOLOGY THROUGH RAPID-CYCLE TECHNOLOGY EVALUATIONS

The emphasis of the role of evidence in the Every Student Succeeds Act (ESSA) provides a unique opportunity to both use and generate evidence to better make education investments.[14] Education technology is an area where this opportunity is particularly rich because these technology tools often make it possible to collect needed data to understand how something is working. Better information about the effectiveness of different technology tools helps educators and administrators make better investments. However, many school and district leaders face barriers in generating meaningful evidence on technology tools and other education investments. They need evaluation tools and processes to conduct low-cost, quick-turnaround evaluations for the types of students they serve.

The U.S. Department of Education has contracted with Mathematica Policy Research to help schools, districts, developers and researchers with conducting rapid-cycle quick-turnaround evaluations using the Ed Tech Rapid Cycle Evaluation Coach. This tool is a free, openly-licensed,web-based platform that provides step-by-step guidance and analysis dashboards for conducting quick-turnaround evaluations of educational technologies.

The IES Low-Cost, Short Duration Evaluation program provides funding for projects that produce research findings that state and district education agencies can use

in making timely decisions regarding the scaling-up or revision of already-adopted education interventions. The evaluations use randomized controlled trials or regression discontinuity designs to determine the impact of interventions on student education outcomes and rely on administrative data or other sources of secondary data to provide measures of these student outcomes.

Quick-turnaround rapid-cycle evaluations will help provide results in a timely manner so that evidence for effectiveness is available to school and district leaders when they need to make purchasing renewal and implementation decisions. These evaluations can also inform efforts to continually improve education technology interventions by helping educators and researchers quickly learn how technologies have affected student outcomes.

TEACH TO LEAD: DEVELOPING TEACHERS AS LEADERS

Teach to Lead, a joint program of the National Board for Professional Teaching Standards, ASCD, and the U.S. Department of Education, aims to advance student outcomes by expanding opportunities for teacher leadership, particularly opportunities that allow teachers to stay in the classroom. With the help of supporting organizations, Teach to Lead provides a platform for teacher-leaders and allies across the country (and around the world) to create and expand on their ideas.

Teach to Lead participants are invested personally in the development of their teacher leadership action plans because the ideas are their own. Participants identify a current problem within their school, district, or community and develop a theory of action to solve that problem. Since its inception in March 2014, Teach to Lead has engaged more than 3,000 educators, in person and virtually through its online platform, with more than 850 teacher leadership ideas spanning 38 states. Teach to Lead regional Teacher Leadership Summits brought together teams of teacher-leaders and supporting organizations to strengthen their teacher leadership ideas, share resources, and develop the skills necessary to make their projects a reality.

Marcia Hudson and Serena Stock, teacher-leaders at Avondale Elementary School in Michigan, identified a need for teacher-led professional development at their school and created a module for teachers to collect and analyze student outcome data to drive new professional development opportunities. The teachers now are holding engagement meetings with teacher-leaders to develop and fund professional development and data collection further.

Chris Todd teaches at Windsor High School in Connecticut and is a former Teacher-Leader-in-Residence for the Connecticut State Department of Education. Chris's team developed the Connecticut Educator Network, a database of teacher-leaders who are readily available to advise on policy development. The network provides opportunities for teachers to hone their leadership skills through training and policy briefings.

Educators can be guides, facilitators, and motivators of learners. The information available to educators through high-speed Internet means teachers do not have to be content experts across all possible subjects. By understanding how to help students access online information, engage in simulations of real-world events, and use technology to document their world, educators can help their students examine problems and think deeply about their learning. Using digital tools, they can help students create spaces to experiment, iterate, and take intellectual risks with all of the information they need at their fingertips.[15,16] Teachers also can take advantage of these spaces for themselves as they navigate new understandings of teaching that move beyond a focus on what they teach to a much broader menu of how students can learn and show what they know.

Educators can help students make connections across subject areas and decide on the best tools for collecting and showcasing learning through activities such as contributing to online forums,

producing webinars, or publishing their findings to relevant websites. These teachers can advise students on how to build an online learning portfolio to demonstrate their learning progression. Within these portfolios, students can catalog resources that they can review and share as they move into deeper and more complex thinking about a particular issue. With such portfolios, learners will be able to transition through their education careers with robust examples of their learning histories as well as evidence of what they know and are able to do. These become compelling records of achievement as they apply for entrance into career and technical education institutions, community colleges, and four-year colleges and universities or for employment.

Educators can be co-learners with students and peers. The availability of technology-based learning tools gives educators a chance to be co-learners alongside their students and peers. Although educators should not be expected to know everything there is to know in their disciplines, they should be expected to model how to leverage available tools to engage content with curiosity and a mindset bent on problem solving and how to be co-creators of knowledge. In short, teachers should be the students they hope to inspire in their classrooms.[17]

CO-LEARNING IN THE CLASSROOM: TEACHER USER GROUPS PROVIDE PEER LEARNING FOR ADULT EDUCATION EDUCATORS

Recognizing the power of virtual peer learning, the U.S. Department of Education's Office of Career, Technical, and Adult Education has funded projects that have established teacher user groups to explore the introduction of openly licensed educational resources into adult education. This model of professional development recognizes that virtual peer learning can support teachers to change their practice and provide leadership and growth opportunities. The small groups of far-flung teachers work with a group moderator to identify, use, and review openly licensed resources in mathematics, science, and English language arts..

Reviews referenced the embedded evaluation criteria in OER Commons, a repository of open educational resources (OER) that can be used or reused freely at no cost and that align to the College- and Career-Readiness mathematics and language arts and Next Generation Science Standards. They also included practice tips for teaching the content to adult learners. The reviews are posted on OER Commons and tagged as **Adult Basic Education** or **Adult English for Speakers of Other Languages** to facilitate the discovery by other teachers of these high-quality, standards-aligned teaching and learning materials.

LEARNING OUT LOUD ONLINE: JENNIE MAGIERA, DISTRICT CHIEF TECHNOLOGY OFFICER AND CLASSROOM TEACHER

Planning a lesson on how elevation and other environmental influences affect the boiling point of water, Jennie Magiera realized that many of the students in her fourth-grade class in Cook County, Illinois, had never seen a mountain. So Magiera reached out to her network of fellow educators through social media to find a teacher in a mountainous area of the country interested in working with her on the lesson..

Soon, Magiera and a teacher in Denver were collaborating on a lesson plan. Using tablets and online videoconferencing, the students in Denver showed Magiera's students the mountains that they could see outside of their classrooms every day. After a discussion of elevation, the two teachers engaged their students in a competition to see which class could boil water faster. By interacting with students in the other class, Magiera's students became engaged more deeply in the project, which led them to develop a richer understanding of ecosystems and environments than they might have otherwise.

Educators can become catalysts to serve the underserved. Technology provides a new opportunity for traditionally underserved populations to have equitable access to high-quality educational experiences. When connectivity and access are uneven, the digital divide in education is widened, undermining the positive aspects of learning with technology.

All students deserve equal access to (1) the internet, high-quality content, and devices when they need them and (2) educators skilled at teaching in a technology-enabled learning environment. When this occurs, it increases the likelihood that learners have personalized learning experiences, choice in tools and activities, and access to adaptive assessments that identify their individual abilities, needs, and interests.

Connected Educators: Exemplars

Technology can transform learning when used by teachers who know how to create engaging and effective learning experiences for their students. In 2014, a group of educators collaborated on a report entitled, *Teaching in the Connected Learning Classroom*. Not a how-to guide or a set of discrete tools, it draws together narratives from a group of educators within the National Writing Project who are working to implement and refine practices around technology-enabled learning. The goal was to rethink, iterate on, and assess how education can be made more relevant to today's youth.

PRODUCING STUDENT FILMS WITH ONLINE AUDIENCES: KATIE MCKAY: LIGHTS, CAMERA, SOCIAL ACTION!

In Katie McKay's diverse, fourth-grade transitional bilingual class, encouraging her students to work together on a project helped them build literacy skills while simultaneously giving them the opportunity to pursue culturally relevant questions related to equity.

McKay recognized that her students were searching for the language to talk about complicated issues of race, gender, power, and equity. To address the competing priorities of preparing her students for the state test and providing them with authentic opportunities to develop as readers and writers, McKay started a project-based unit on the history of discrimination in the United States.

Students worked in heterogeneously mixed groups to develop comic strips that eventually were turned into two videos, one showing micro-aggressions students commonly see today and one about the history of discrimination in the United States. The movie on micro-aggressions portrayed current scenarios that included characters who acted as agents of change, bravely and respectfully defending the rights of others.

According to McKay, students who previously were disengaged found themselves drawn into the classroom community in meaningful and engaging ways. While reflecting on this unit, McKay wrote:

> "We were not only working to promote tolerance and appreciation for diversity in our community. We also were resisting an oppressive educational context. In the midst of the pressure to perform on tests that were isolating and divisive, we united in collaborative work that required critical thinking and troubleshooting. In a climate that valued silence, antiquated skills, and high-stakes testing, we engaged in peer-connected learning that highlighted 21st century skills and made an impact on our community."[18]

JUST-IN-TIME LEARNING: JANELLE BENCE: HOW DO I TEACH WHAT I DO NOT KNOW?

Texas teacher Janelle Bence was looking for new ways to engage and challenge her students, the majority of whom are English language learners from low-income families. After observing her students' motivation to persist through game challenges, she wondered if games held a key to getting them similarly engaged in classwork. After attending a session on gaming at a National Writing Project Annual Meeting, Bence was inspired to incorporate gaming into her classroom. She did not know anything about gaming and so, as is the case for many teachers seeking to bridge the gap between students' social interests and academic subjects, she had to figure out how to teach what she did not know.

Bence started by reading a book about using video games to teach literacy. As she read, she shared her ideas and questions on her blog and talked to other educators, game designers, and systems thinkers. Through these collaborations, she decided that by creating games, her students would be required to become informed experts in the content of the game as well as to become powerful storytellers.

As she explored games as a way to make academic tasks more engaging and accessible for her students, Bence found it was important to take advantage of professional learning and peer networks, take risks by moving from a passive consumer of knowledge to actually trying the tasks that she planned to use with students, and put herself in her students' shoes.

Bence shared that "finding a way to connect to students and their passions—by investigating what makes them tick and bridging [those passions] to academic tasks—educators are modeling risks that encourage the same behavior in their learners."[19]

BUILDING STUDENT AGENCY: JASON SELLERS: TEXT-BASED VIDEO GAMES

Aware of the popularity of video games among his students, and as a longtime fan of video games himself, teacher Jason Sellers decided to use gaming to develop his 10th-grade students' ability to use descriptive imagery in their writing. Specifically, Sellers introduced his students to text-based video games. Unlike graphics-based games in which users can view graphics and maneuver through the game by using controller buttons, text-based games require players to read descriptions and maneuver by typing commands such as go north or unlock the door with a key. Sellers decided his students could practice using descriptive imagery by developing their own text-based games.

https://commons.wikimedia.org/wiki/File:US_Navy_101013-N-8863V-522_Eighth_grade_students_from_Mira_Loma_Middle_School_use_a_ground_tracking_system_during_the_11th_annual_Science_and_Techn.jpg

Using tutorials and other resources found on Playfic, an interactive fiction online community, Sellers created lessons that allowed students to play and eventually create interactive fiction games. Prior to the creation of the games, Sellers's class analyzed several essays that skillfully used descriptive imagery, such as David Foster Wallace's *A Ticket to the Fair*, and composed short pieces of descriptive writing about their favorite locations in San Francisco.

Students then transferred their newly honed descriptive storytelling skills to the development of an entertaining text-based game. Because Sellers's students wanted to develop games their peers would want to play, they focused on ways to make their games more appealing, including, as Sellers described, "using familiar settings (local or popular culture), familiar characters (fellow students or popular culture), and tricky puzzles."[20]

According to Sellers, this project allowed students to work through problems collaboratively with peers from their classroom and the Playfic online community and motivated them to move beyond basic requirements to create projects worthy of entering competitions.

Rethinking Teacher Preparation

Teachers need to leave their teacher preparation programs with a solid understanding of how to use technology to support learning. Effective use of technology is not an optional add-on or a skill that we simply can expect teachers to pick up once they get into the classroom. Teachers need to know how to use technology to realize each state's learning standards from day one. Most states have adopted and are implementing college- and career-ready standards to ensure that their students graduate high school with the knowledge and skills necessary to succeed.

New college and career-ready standards include many mentions of technology expectations. Federal, state, and district leaders nationwide have made significant investments in providing infrastructure as well as devices to schools. Without a well-prepared teaching force, the nation will not experience the full benefits of those investments for transformative learning.

Based on recommendations from the field, teacher preparation innovators collaborated with the Office of Educational Technology (OET) and developed four guiding principles for the use of technology in pre-service teacher preparation programs that can be found in the Advancing Educational Technology in Teacher Preparation policy brief. These principles are as follows:

ADVANCING EDUCATIONAL TECHNOLOGY IN TEACHER PREPARATION: FOUR GUIDING PRINCIPLES

1. Focus on the active use of technology to enable learning and teaching through creation, production, and problem-solving.
2. Build sustainable, program-wide systems of professional learning and teaching.
3. Ensure pre-service teachers' experiences with educational technology are program-deep and program-wide, rather than one-off courses separate from their methods courses.
4. Align efforts with research-based standards, frameworks, and credentials recognized across the field.

Teacher preparation programs across the nation have publicly committed to working toward the four principles and better preparing its students by giving them the skills needed to meaningfully use technology in their future classrooms. The Advancing Educational Technology in Teacher Preparation Policy Brief further details the recommendations for teacher preparation programs. Read the brief at: https://tech.ed.gov/teacherprep/.

This brief further details the recommendations for teacher preparation programs to better prepare its students to use technology as a tool to transform teaching and learning experiences in the P-12 classroom as well as highlights examples of these recommendations in action.

Schools should be able to rely on teacher preparation programs to ensure that new teachers come to them prepared to use technology in meaningful ways. No new teacher exiting a preparation

program should require remediation by his or her hiring school or district. Instead, every new teacher should be prepared to model how to select and use the most appropriate apps and tools to support learning and evaluate these tools against basic privacy and security standards. It is inaccurate to assume that because pre-service teachers are tech savvy in their personal lives they will understand how to use technology effectively to support learning without specific training and practice. This expertise does not come through the completion of one educational technology course separate from other methods courses but through the inclusion of experiences with educational technology in all courses modeled by the faculty in teacher preparation programs.

ALIGNING EDUCATION WITH TECHNOLOGY STANDARDS: UNIVERSITY OF MICHIGAN

Pre-service teachers at the University of Michigan School of Education are experiencing the kind of learning with technology their students will one day know. The curriculum addresses each of the five ISTE Standards for Teachers[21] and aligns with skills from the Partnership for 21st Century Skills.[22] Each standard also has related course projects designed for teacher candidates to use technology actively to demonstrate their understanding of the material through practice and feedback. For example, teacher candidates are asked to design and teach a 20-minute webinar for fourth graders that is based on Next Generation Science Standards and to design and teach a lesson that uses technology and meets the needs of their learners as part of their student teaching placement.

PREPARING TO TEACH IN TECHNOLOGY ENABLED ENVIRONMENTS: SAINT LEO UNIVERSITY

A 2006 survey of Saint Leo University teacher preparation program alumni showed satisfaction with their preparation with one notable exception—technology in the classroom. As a result, the education department established a long-term goal of making technology innovation a keystone of its program. Saint Leo faculty redesigned their program on the basis of the Technological Pedagogical and Content Knowledge model, in which pre-service teachers learned to blend content, pedagogical, and technological knowledge in their PK–12 instruction.[23]

Faculty developed their expertise with different technologies so that every course models the use of technology to support teaching and learning. The school built an education technology lab where teacher candidates can practice using devices, apps, and other digital learning resources. Students regularly reflect on their experience using technology to increase effectiveness and efficiency as well as its value in the learning process.

Perhaps most notably, Saint Leo ensures all pre-service teachers have basic technologies available at their student teaching placements. Each pre-service teacher is given a digital backpack with a tablet, portable projector, speakers, and a portable interactive whiteboard. A student response system is also available for pre-service teachers to use in their field placements.

ADVANCING KNOWLEDGE AND PRACTICE OF ASSISTIVE TECHNOLOGIES: ILLINOIS STATE UNIVERSITY

Illinois State University's Department of Special Education is one of the largest special education training programs in the nation. Recognizing the value of assistive technology in meeting the needs of each student, the special education teacher preparation program at the University includes an extensive emphasis on selection and use of assistive technologies.

Classroom learning is brought to life through ongoing clinical and field-based experiences in schools and at the university's Special Education Assistive Technology Center. The center provides hands-on experiences to pre-service teachers enrolled in the special education programs at Illinois as well as opportunities for teachers, school administrators, family members, and businesses to learn about assistive technologies. Furthermore, faculty work in partnership with a variety of public, private, and residential schools to enhance student field experiences and provide opportunities for students to work with learners with a range of disabilities and in a variety of settings, including rural, urban, and suburban areas.

BUILDING DIGITAL LITERACY IN TEACHERS: UNIVERSITY OF RHODE ISLAND (URI)

A critical aspect of ensuring that young Americans learn appropriate digital literacy skills is equipping educators at all levels with the same skills. To that end, URI offers a graduate certificate in digital literacy for graduate students, classroom teachers, librarians, and college faculty. By targeting a broad audience to participate in the program, URI is expanding the number of educators with the professional capacity to help students to learn, access, analyze, create, reflect, and take action using digital tools, texts, and technologies in all aspects of their lives.

During the program, students are introduced to key theories of digital literacy in inquiry-driven learning and given time to experiment with and explore a wide range of digital texts, tools, and technologies. In collaboration with a partner, they create a project-based instructional unit that enables them to demonstrate their digital skills in the context of an authentic learning situation. Throughout the program, students participate in hands-on, minds-on learning experiences; participants build a deeper understanding of digital literacy while developing practical skills and have time to reflect on the implications of the digital shift in education, leisure, citizenship, and society.

In its evaluation of the program, URI has found that participants experienced a dramatic increase in digital skills associated with implementing project-based learning with digital media and technology. Their understanding of digital literacy also shifted to focus more on inquiry, collaboration, and creativity.

Fostering Ongoing Professional Learning

The same imperatives for teacher preparation apply to ongoing professional learning. Professional learning and development programs should transition to support and develop educators' identities as fluent users of technology; creative and collaborative problem solvers; and adaptive, socially aware experts throughout their careers. Programs also should address challenges when it comes to using technology learning: ongoing professional development should be job embedded and available just in time.[24]

INCREASING ONLINE PROFESSIONAL COLLABORATION: CONNECTED EDUCATOR MONTH BUILDS COLLABORATION ACROSS THE COUNTRY

Connected Educator Month, launched initially as part of the U.S. Department of Education's Connected Educators project, began with a monthlong online conference that included a centralized guiding structure, kickoff and closing events, engagement resources, and an open calendar to which organizations of all types could submit professional learning events and activities. Educators used these resources and the calendar to create their own professional development plan for the month. Available activities included webinars, Twitter chats, forum discussions, and actively moderated blog discussions based on personal learning needs and interests.

In the first year, more than 170 organizations provided more than 450 events and activities, with educators completing an estimated 90,000 hours of professional learning across the month. More than 4 million people followed the #ce12 hashtag on Twitter, generating 1.4 million impressions per day.

Now led by partner organizations from the original Connected Educators project—American Institutes for Research (AIR), Grunwald Associates LLC, and Powerful Learning Practice—Connected Educator Month features more than 150 organizations and has provided more than 1,000 events and activities. Australia, New Zealand, and Norway hosted their own iterations of Connected Educator Month, and educators in more than 125 countries participated in some way.

PUTTING LEARNING IN TEACHERS' HANDS: DENVER PUBLIC SCHOOLS PERSONALIZE PROFESSIONAL DEVELOPMENT

In 2014, 80 teachers from 45 schools engaged in the pilot year of Project Cam Opener, an initiative of the Personalized Professional Learning team in Denver Public Schools. In its second year with 425 teachers and leaders, Project Cam Opener allows educators to record their teaching with customized video toolkits and share those videos for self-reflection and feedback within an online community of practice.

In the program's pilot year, the first 80 teachers recorded hundreds of videos using tools such as Swivls, iPads, high-definition webcams, and microphones. The videos were uploaded to private YouTube channels and shared via a Google+ community for feedback. For many of these teachers, it was the first time that they had seen the teaching practices of other teachers in their district. The videos sparked daily conversations and sharing of ideas.

Three measures are used to determine the effectiveness of Project Cam Opener: engagement, retention, and observation. In the first end-of-year survey, 90 percent of respondents said that taking part in Project Cam Opener made them more engaged in their own professional learning and growth. In addition, not a single teacher from the pilot group left Denver Public Schools after their year with Project Cam Opener (the overall district rate of turnover is 20 percent). Although teacher observation scores are harder to attribute to this project specifically, the growth of this cohort of teachers outpaced that of their non–Project Cam Opener counterparts, according to the district's Framework for Effective Teaching. As of the 2016-17 school year, Project Camp Opener is committed to establishing an open community of practice. Therefore any educator in Denver Public Schools and beyond are welcome to participate in the new #ProjCO.

MICRO-CREDENTIALING TEACHER COMPETENCIES: KETTLE MORAINE INTRODUCES TEACHER-LED PROFESSIONAL LEARNING

Kettle Moraine School District in Wisconsin is creating a professional learning environment in which practicing teachers can be the masters and architects of their own learning. Using the Digital Promise educator micro-credentialing framework as a guide (for more information on Digital Promise's micro-credentialing work, see Section 4: Leadership), teachers in the district take a technology proficiency self-assessment, which they use as a baseline for their personal professional growth. The teachers then work by themselves and in collaborative teams to develop specific professional learning goals aligned to district strategic goals, which they submit to district leadership for approval.

Once these goals are approved, the teachers establish measurable benchmarks against which they can assess their progress. Both the goals and benchmarks are mapped to specific competencies, which, in turn, are tied to micro-credentials that can be earned once teachers have demonstrated mastery. Demonstrations of mastery include specific samples of their work, personal reflections, classroom artifacts, and student work and reflections, which are submitted via Google Forms to a committee of 7 to 10 teachers who review them and award micro-credentials.

After the initial successful pilot with 49 teachers, an additional 151 faculty members elected to earn a micro-credential on personalized learning, which requires them to conduct their own background research and engage in regularly scheduled Twitter chats as well as blogging, networking, and other forms of self-guided learning using technology. Many have engaged with teachers across the country, allowing them to give and receive ideas, resources, and support.

EMBRACING THE UNCONFERENCE: GOING TO EDCAMP

An educator attending an Edcamp event engages in a professional learning experience vastly different from traditional professional development. Sessions are built on the interests and needs of the people who attend and are created on the day by using a cloud-based collaborative application that is open to all (including those unable to participate in person). Each teacher chooses which sessions to attend on the basis of individual interests or needs.

Because using technology in learning effectively is one of the challenges facing teachers, sessions frequently are organized around sharing practices and overcoming common challenges when improving practices around the use of technology. Teachers collaborate to overcome challenges together, often making connections that lead beyond the single session or day, as partnerships are formed to engage their students with each other. The shared documents created at these events become an archive and resource for whoever attended, in person or virtually.

The first Edcamp was organized in Philadelphia by a group of local educators interested in new unconference (self-organizing) approaches to a conference for professional learning. The model took off, and as of January 2016 there have been more than 1000 Edcamps all organized by local educators. The enormous popularity of the format has led to the formation of the Edcamp Foundation, a nonprofit organization that will formalize much of the ad hoc support that has been provided to Edcamp organizers until now.

Recommendations

- **Provide pre-service and in-service educators with professional learning experiences powered by technology to increase their digital literacy and enable them to create compelling learning activities that improve learning and teaching, assessment, and instructional practices.**
  To make this goal a reality, teacher preparation programs, school systems, state and local policymakers, and educators should come together in the interest of designing pre- and in-service professional learning opportunities that are aligned specifically with technology expectations outlined within state standards and that are reflective of the increased connectivity of and access to devices in schools. Technology should not be separate from content area learning but used to transform and expand pre- and in-service learning as an integral part of teacher learning

- **Use technology to provide all learners with online access to effective teaching and better learning opportunities with options in places where they are not otherwise available.**
  This goal will require leveraging partner organizations and building institutional and teacher capacity to take advantage of free and openly licensed educational content such as those indexed through Learning Registry's #GoOpen Node (LearningRegistry.org). Adequate connectivity will increase equitable access to resources, instruction, expertise, and learning pathways regardless of learners' geography, socio-economic status, or other factors that historically may have put them at an educational disadvantage.

- **Develop a teaching force skilled in online and blended instruction.**
  Our education system continues to see a marked increase in online learning opportunities and blended learning models in traditional schools. To meet the need this represents better, institutions of higher education, school districts, classroom educators, and researchers need to come together to ensure practitioners have access to current information regarding research-supported practices and an understanding of the best use of emerging online technologies to support learning in online and blended spaces.

- **Develop a common set of technology competency expectations for university professors and candidates exiting teacher preparation programs for teaching in technologically enabled schools and postsecondary education institutions.**
  There should be no uncertainty of whether a learner entering a PK–12 classroom or college lecture hall will encounter a teacher or instructor fully capable of taking advantage of technology to transform learning. Accrediting institutions, advocacy organizations, state policymakers, administrators, and educators have to collaborate on a set of clear and common expectations and credentialing regarding educators' abilities to design and implement technology-enabled learning environments effectively.

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3. Leadership

Creating a Culture and Conditions for Innovation and Change

GOAL: Embed an understanding of technology-enabled education within the roles and responsibilities of education leaders at all levels and set state, regional, and local visions for technology in learning

Taking full advantage of technology to transform learning requires strong leadership capable of creating a shared vision of which all members of the community feel a part. Leaders who believe they can delegate the articulation of a vision for how technology can support their learning goals to a chief information officer or chief technology officer fundamentally misunderstand how technology can impact learning. Technology alone does not transform learning; rather, technology helps enable transformative learning. The vision begins with a discussion of how and why a community wants to transform learning. Once these goals are clear, technology can be used to open new possibilities for accomplishing the vision that would otherwise be out of reach. Moving to learning enabled by technology can mean a shift in the specific skills and competencies required of leaders. Education leaders need personal experience with learning technologies, an understanding of how to deploy these resources effectively, and a community-wide vision for how technology can improve learning.[1]

Although leadership in technology implementation is needed across all levels of the education system, the need in PK–12 public schools is acute. The 2016 Consortium for School Networking (CoSN) Annual E-rate and Infrastructure Survey found that 81percent of school systems have met the FCC's short-term goal of 100 megabits per second of Internet bandwidth per 1,000 students. Although we still have progress to make, this is a significant improvement from 2013 when only 19 percent reached the goal.[2] Recent changes to the federal E-rate program make funding available to increase connectivity to the remaining schools; however, these transitions will not happen without strong leadership at state, district, and school levels

SETTING NATIONAL PRIORITIES: ConnectED INITIATIVE

In June 2013, President Obama announced the ConnectED initiative, which had four goals:

1. Within five years, connect 99 percent of America's students through next-generation broadband and high-speed wireless in their schools and libraries
2. Empower teachers with the best technology and training to help them keep pace with changing technological and professional demands

3. Provide students with feature-rich educational devices that are price competitive with basic textbooks
4. Empower students with digital learning content and experiences aligned with college- and career-ready standards being adopted and implemented by states across America

For guidance on how these goals are being operationalized, see the U.S. Department of Education's Future Ready Schools: Building Technology Infrastructure for Learning and the White House's ConnectED resources.

FUTURE READY

To help support leaders' move toward creating the technical infrastructure and human capacity necessary to fully implement this vision for transformative learning enabled by technology, the U.S. Department of Education partnered with the Alliance for Excellent Education and more than 40 other partner organizations to launch Future Ready in November 2014. The department also challenged superintendents to indicate their commitment to transform teaching and learning in their districts by signing the Future Ready District Pledge. As of January 2017, over 3100 school districts across the United States have signed the Future Ready District Pledge, impacting over 19 million students across the nation, 25 states and Washington, D.C., have launched Future Ready statewide initiatives, and over 60 partner organizations have committed to supporting the shift to transformative digital teaching and learning. To review the Future Ready District Pledge and see which districts have signed, visit http://www.futurereadyschools.org/take-the-pledge. For more information on Future Ready and to access a growing set of curated resources that align to the Future Ready framework from more than 60 partners, such as CoSN's Certified Education Technology Leader certification for school district leaders, visit http://www.futureready.org.

Characteristics of Effective Leadership

Selected by synthesizing the best available research and practice knowledge, the following were identified as four key focus areas of effective leadership: collaborative leadership, personalized student learning, robust infrastructure, and personalized professional learning.[3]

Future Ready Leaders

To support the unique needs of superintendents and district leaders, the U.S. Department of Education identified and then filmed eight Future Ready districts that exemplified four key focus areas of effective leadership. The resulting collection of 47 research-based, short videos break down specific actions taken by these district leaders to transform teaching and learning and serve as a virtual site visit and serve essentially as virtual site visits. Superintendents can take a short survey that results in a personalized, on-demand video playlist of effective Future Ready leadership in action. For more information about the Future Ready Leaders project and access to the survey and videos, visit the U.S. Department of Education Future Ready Leaders website at https://tech.ed.gov/leaders.

Collaborative Leadership

- Education leaders develop a shared vision for how technology can support learning and how to secure appropriate resources to sustain technology initiatives. Leaders seek input from a diverse team of stakeholders to adopt and communicate clear goals for teaching, leading, and learning that are facilitated by technology. They model tolerance for risk and experimentation and create a culture of trust and innovation.
- Leaders communicate with all stakeholders by using appropriate media and technology tools and establish effective feedback loops. While implementing the vision through a collaboratively developed strategic plan, leaders use technology as a learning tool for both students and teachers. Leaders are creative and forward- thinking in securing sustainable streams of human and capital resources to support their efforts, including appropriate partnerships both within their institutions and beyond.
- In order for education research to have the most impact on practice, it is critical for practitioners at the school and district level to use and understand research. The Institute of Education Sciences supports two National Research and Development Centers on Knowledge Utilization, tasked with learning how research is used in schools and districts during decision-making (http://www.ncrpp.org and http://www.research4schools.org). Early results suggest that district leaders value education research and use it to expand their understanding of education issues and when making decisions about professional development and curriculum adoption.

FACILITATING OPEN COMMUNICATION: CHULA VISTA ELEMENTARY SCHOOL DISTRICT (CVESD) DEVELOPS MOBILE APP FOR COMMUNICATING WITH PARENTS

CVESD recognized that it needed to do better in reaching the families of its approximately 30,000 students across 45 schools, more than 50 percent of whom are enrolled in the free or reduced-price lunch program and 30 percent of whom are English language learners. CVESD's traditional email and newsletter communications were more accessible to their higher income families than to their lower income families, so CVESD reached out to district families to understand how they might be able to communicate more effectively.

Through their conversations, CVESD discovered that 99 percent of families had consistent access to a smartphone and that most used social media often. Working closely with parents, CVESD created a Facebook page, Twitter accounts, and a mobile app. Parent suggestions, such as the ability to check cafeteria account balances so they could track the money they gave their children for lunch and the ability to import school events to personal calendars, were incorporated into the CVESD Mobile App, launched in November 2014. Families have the option of receiving this and other information through the mobile app in Spanish.

Personalized Student Learning

- Technology enables personalized pathways for student learning through active and collaborative learning activities. Clearly defined sets of learning outcomes guide instruction. The outcomes, and the aligned curriculum, instruction, and assessment, reflect the multidisciplinary nature of knowledge; prepare students for our participatory culture through attention to digital literacy and citizenship; and attend to general skills and dispositions, such as reflection, critical thinking, persistence, and perseverance.

- Leaders ensure that policies and resources equip teachers with the right tools and ongoing support to personalize learning in their classrooms.
- Teachers collaborate to make instructional decisions based on a diverse data set, including student and teacher observations and reflections, student work, formative and summative assessment results, and data from analytics embedded within learning activities and software aided by real-time availability of data and visualizations, such as information dashboards. Leadership policy and teacher methods support student voice and choice in the design of learning activities and the means of demonstrating learning. Students frequently complete a series of self-directed, collaborative, multidisciplinary projects and inquiries that are assessed through a profile or portfolio. Technology is integral to most learning designs, used daily within and beyond the classroom for collaboration, inquiry, and composition, as well as for connecting with others around the world. In the classroom, teachers serve as educational designers, coaches, and facilitators, guiding students through their personalized learning experiences.

Robust Infrastructure

- A robust technology infrastructure is essential to transformative digital learning environments, and leaders need to take ownership of infrastructure development and maintenance. The 2016 CoSN Annual E-rate and Infrastructure Survey found that affordability still remains the primary obstacle for robust connectivity even though progress has been made; network speed and capacity pose significant challenges for schools; and, finally, too many school systems report a lack of competition for broadband services in many parts of the United States, particularly in rural areas.[4] Leaders are responsible for meeting these challenges and ensuring ubiquitous access among administrators, teachers, and students to connectivity and devices and for supporting personnel to ensure equipment is well maintained. Effective leaders take direct responsibility to ensure infrastructure remains up-to-date (both in terms of security and relevant software, apps, and tools) and open to appropriate Web content and social media tools to enable collaborative learning. Leaders also recognize the importance of building capacity among those responsible for creating and maintaining the technology infrastructure. Effective leaders support all of these efforts through careful planning and financial stewardship focused on long-term sustainability.

Personalized Professional Learning

- Leaders ensure the availability of ongoing, job-embedded, and relevant professional learning designed and led by teachers with support from other experts. Leaders develop clear outcomes for professional learning aligned with a vision for student learning.
- Teachers and leaders engage in collaborative inquiry to build the capacity of both the participating staff and the school as a whole through face-to-face, online, and blended professional learning communities and networks. Leaders ensure that professional learning planning is participatory and ongoing. Leaders learn alongside teachers and staff members, ensuring that professional learning activities are supported by technology resources and tools, time for collaboration, and appropriate incentives.

Implementation is Key

Although vision is critical to transforming teaching and learning, a strategic implementation plan is key to success. In some states, districts or schools will develop their own technology implementation plans; in others, state education leaders take the lead and districts follow. The Alliance for Excellent Education's Future Ready website provides one example of free online assessment tools to be completed by district teams. The resulting reports are designed to help district teams create a comprehensive implementation plan that accounts for the four Future Ready focus areas as well as implementation strategies and resources.

In addition to working with teams within educational organizations to create an implementation plan, leaders also should solicit input and feedback from a broad range of influencers: administrators, teacher-leaders experienced in using technology to support learning, professional organizations, boards of education, knowledgeable members of the community, business leaders, cultural institutions, colleagues in other districts, and parents.[5]

LEADING BY EXAMPLE: VAN HENRI WHITE, SCHOOL BOARD PRESIDENT

Many school board members assume their responsibilities mostly focus on approving budgets and making hiring decisions. Van Henri White, Rochester, New York, School Board President and Council of Urban Boards Education Chair, sees transforming teaching and learning as the responsibility of all educational leaders, including and beyond a district's superintendent. White believes part of leading a board means learning and leveraging the same technology tools he hopes his district's teachers are using to support learning in classrooms. For example, during Rochester's observance of Martin Luther King Day in 2015, White joined Rochester educators, students, and staff as they engaged in a videoconference session with districts across the country, including New York City; Miami-Dade; and Ferguson, Missouri, for a structured conversation about race and civil rights in America.

White also believes in the importance of establishing connectivity beyond a district's facilities. He and other district leaders in Rochester have begun conversations with local city and county leaders to provide wireless Internet access for homes and families throughout the district. He sees such access to technology and connectivity as more than a district tool—as one to be leveraged for family learning as well. White hopes district-wide wireless access will mean parents will be able to help their students by looking up academic content they may not understand and will provide equitable access to district-provided tools such as its online communication portal.

U.S. DEPARTMENT OF EDUCATION STATE RESOURCES IN DEVELOPMENT

The U.S. Department of Education has contracted the State Educational Technology Directors Association (SETDA) to develop a State Level Professional Learning Resources Package and Influencer Toolkits for release in June 2017. These resources will support states as well as provide an avenue to engage with their districts to 1. support the implementation of transformative digital learning, 2. help close the digital divide, and 3. increase student achievement.

Professional learning resources will include concrete examples and key elements to support the creation and revision of district digital learning plans. The influencer toolkits will be designed to promote collaborative state leadership and include sample

presentations, workshop outlines, checklists, and communication tools. In an effort to be inclusive, audiences will include school boards, principals, district leadership, parents, and the business community.

SETTING AN AGENDA FOR CHANGE: HOWARD-WINNESHIEK (HOWARD-WINN) COMMUNITY SCHOOL DISTRICT

John Carver, Superintendent of Howard-Winn Community School District, faced less than optimal conditions when he initiated a digital learning transformation project modeled on Future Ready Schools. The district was experiencing declining enrollment and was failing to meet the standards of No Child Left Behind in reading comprehension, and almost half of the district's students qualified for free or reduced-priced lunch. Many districts face similar challenges; what set Howard-Winn apart was the district's decision to view failure as an opportunity to learn and improve.

Despite a lack of funding and community reluctance to change, Carver successfully gained support by working closely with teachers, the school board, and the district's School Improvement Advisory Committee to set an ambitious goal: By the year 2020, children in Howard-Winn will be the best prepared, most recruited kids on the planet.[6]

Creating a new brand, *2020 Howard-Winn*, helped Carver communicate the district vision of technology embedded in all parts of instruction, social and online systems of support for district professionals, and active community buy-in and participation. Behind these three pillars are leadership attributes essential to change: the courage to identify challenges and create a sense of urgency; openness to invest time, build trust, and cultivate relationships with stakeholders; and constant availability, visibility, and ownership as the drivers and face of change.

Although the implementation is still in its early stages, the district has acquired 1,300 laptops and implemented a 1:1 program. Teachers are challenged to be digital explorers and are asked to seek professional development opportunities proactively by using technology and to teach their students to be good digital citizens.

Since implementing these measures, student attendance at Howard-Winn schools has improved 90 percent, and a tech-enabled partnership with Northeast Iowa Community College has saved students between $9,000 and $10,000 in tuition fees by allowing district students to access college coursework while still in high school. The district also has seen a 17 percent increase in students meeting and exceeding summative assessment benchmarks. With more than $250,000 in support from stakeholders, the district also has been able to implement sustainable and cost-saving measures such as solar-powered Wi-Fi routers and propane-powered buses. The district has also created and publicized #2020HowardWinn - which reflects their commitment to be a transformed 21st century educational system by the year 2020.

As the district continues to implement its vision of digital learning, Carver says he and other leaders have been driven by the following question: "Do we love our kids enough to stop doing the things that do not work anymore?"

PROVIDING STATEWIDE LEADERSHIP: NORTH CAROLINA'S DIGITAL LEARNING PLAN

To accelerate progress toward the goal of providing equitable access to high-quality learning for all K–12 students in the state, North Carolina asked the Friday Institute for Educational Innovation at North Carolina State University to develop the North Carolina Digital Learning Plan. Beginning in June 2014, the Friday Institute engaged in a multi-faceted planning process, building on prior research and work on digital learning initiatives, with schools and districts across North Carolina.

The planning process included site visits to 18 districts and various charter schools and included 164 focus groups and interviews with superintendents, principals, teachers, technology directors, curriculum and instruction directors, chief financial officers, professional development directors, instructional technology facilitators, technicians, parents, and students.

In addition, Friday Institute researchers met with the deans of education of both the University of North Carolina system and independent colleges and universities across North Carolina, local school board members, legislators, business leaders, nonprofit education organizations, and other stakeholders. The researchers gathered data and analyzed the technology infrastructure of all of North Carolina's K–12 public schools, using the information to help prepare the state's E-rate application.

Friday Institute staff also conducted reviews of existing research on digital learning programs and gathered information about initiatives and strategies from other states and large districts. The North Carolina Digital Learning Plan can be found here.

Budgeting and Funding for the Transition to Digital Learning

Districts often are challenged financially when it comes to implementing technology initiatives and programs. Once a vision for the use of technology is in place, district superintendents and school leaders first should examine existing budgets to identify areas in which spending can be reduced or eliminated to pay for learning technologies. They also should consider all possibilities for creative funding of these programs. The following approaches are recommended for consideration as districts review their budgets and funding.

Eliminate or Reduce Existing Costs

As technology enables new learning opportunities and experiences, it also can render existing processes and tools obsolete, freeing up funds to pay for technology. Three obvious examples are copy machines (and related supplies and services contracts), dedicated computer labs, and replacing commercially licensed textbooks with openly licensed educational resources. As part of #GoOpen, OET challenged schools to begin this process by replacing just one textbook with openly licensed educational resources as a first step in appreciating the cost savings and developing an understanding of what would be necessary to implement such a change school- or district-wide.

OPENLY LICENSED EDUCATIONAL RESOURCES

Openly licensed educational resources are teaching, learning, and research resources that reside in the public domain or have been released under a license that permits their use, modification, and sharing with others. Open resources may be full online courses or digital textbooks or more granular resources such as images, videos, and assessment items..

TURNING TOWARD OPEN: ILLINOIS SCHOOL DISTRICT EMBRACES OPENLY LICENSED DIGITAL RESOURCES

Many schools are freeing up funds for digital resources by transitioning away from textbooks. The state of Illinois offered Williamsfield Community Unit School District three options when tasked with selecting instructional materials aligned with new mathematics standards: valid and reliable outside sources of material that aligned with standards, a mathematics model scope and sequence developed by the Illinois State Board of Education, or a textbook series.

With a limited budget of $10,000, the district decided to forgo traditional textbook adoption and instead began the process of creating and using openly licensed content. The district relied on a mathematics scope and sequence framework openly provided by the Dana Center and used a variety of open source content through OER Commons and Learning Registry. With the money previously allotted for textbooks, the district purchased low-cost, cloud-based laptop computers. In addition, leadership allocated federal Rural Education Achievement Program and Title II funding to procure devices and upgrade connectivity infrastructure.

Recognizing a need to build professional capacity around these new resources, district leadership dedicated professional development time, including pullout days with class coverage, to help teachers better understand how to curate, collaborate, and house digital content. In addition, the teachers are using collaborative cloud-based storage to house their repository of content. The approach has spread beyond mathematics instruction into other subjects as well, setting a tone and track for the district's growing STEM initiative.

The district routinely evaluates the user experience of the openly licensed resources. Follow-up efforts will encourage the district's most innovative teachers to remix or contribute original openly licensed learning resources, leveraging the Illinois Shared Learning Environment OER tool set to do so.

Partner With Other Organizations

Partnership options for securing resources include local businesses and other organizations, alumni, internal and nearby teacher experts to provide professional development, and curriculum development arrangements with other districts. Some school districts have formed partnerships with local and county governments, sharing technology infrastructure and technical staff to keep costs down by jointly funding chief technology officer roles and taking advantage of the economies of scale when building and purchasing broadband access together. These economies of scale also can be realized through consortium purchasing such as the Kentucky Valley Educational Cooperative, which represents several districts and higher education institutions at once and helps decide issues of resource allocation.

Make Full Use of Federal Funds

The E-rate program provides substantial price discounts for infrastructure costs for schools and public libraries and is one source of technology funding. In addition, for funding beyond connectivity, a U.S. Department of Education Dear Colleague letter, published in November 2014 and updated in January 2017, provides guidance and examples for leveraging existing federal funds for technology-related expenditures.

USING FEDERAL FUNDS: U.S. DEPARTMENT OF EDUCATION DEAR COLLEAGUE LETTER ON ACCEPTABLE USES OF FEDERAL FUNDING FOR TECHNOLOGY

The purpose of the Dear Colleague letter published by the U.S. Department of Education in November 2014 and updated in January 2017 is to help state, district, and eligible partnership grantees better understand how they may be able to use their federal grant funds to support innovative technology-based strategies to personalize learning. The letter includes examples of how funds from the Elementary and Secondary Education Act (Titles I, II, and III) and Individuals with Disabilities Education

Act (IDEA) may support the use of technology to improve instruction and student outcomes. Examples were limited to the Elementary and Secondary Education Act and IDEA because of the scale of these programs, but funds from many other formula and competitive grant programs that are administered by the U.S. Department of Education also may be used for this purpose.

The examples do not depart from previous U.S. Department of Education guidance but rather clarify opportunities to use federal grant funds to support digital learning, including improving and personalizing professional learning and other supports for educators, increasing access to high-quality digital content and resources for students, facilitating educator collaboration and communication, and providing devices for students to access digital learning resources. Funding these four areas is important because technology itself is not a panacea.

STUDENT SUPPORT AND ACADEMIC ENRICHMENT (SSAE) GRANTS

In October 2016 the U.S. Department of Education released Non-Regulatory Guidance: Student Support and Academic Enrichment (SSAE) Grants. This grant program, newly authorized by the ESEA as amended by ESSA, focuses on activities to support well-rounded education, safe and healthy students, and the effective use of technology. This guidance highlights some of the ways that SSAE funds can be used to meet the following goals for improving the effective use of technology:

1. Supporting high-quality professional development for educators, school leaders, and administrators to personalize learning and improve academic achievement
2. Building technological capacity and infrastructure
3. Carrying out innovative blended learning projects
4. Providing students in rural, remote and underserved areas with the resources to benefit from high quality digital learning opportunities
5. Delivering specialized or rigorous academic courses and curricula using technology, including digital learning technologies and assistive technology

LEAs may use SSAE funds to build technological capacity and infrastructure by purchasing devices, equipment, and software applications to address readiness shortfalls. Districts may not use more than 15% of the funds provided under section 4109(a) for this purpose. ESEA, secs. 4109(a)(2); 4109(b) Please see the non-regulatory guidance on Title IV, Part A for more information.

CREATIVE FUNDING SOLUTIONS: EDGECOMBE COUNTY PUBLIC SCHOOLS COMBINES FUNDING SOURCES TO PAY FOR IT

Edgecombe County Public Schools in North Carolina has one of the highest dropout rates in the state and three of the lowest performing elementary schools, and during the past few years nearly 700 students (of 6,200 students served) have left the district in favor of other options. To change these staggering statistics, Edgecombe County Public School leaders made a district-wide commitment to an evidence-based global education approach that is supported by technology and funded through an innovative model that combines federal funding with the use of free online educational resources.

The revised district-wide technology plan, which includes statewide access to free digital teaching and learning resources, now also reflects the North Carolina State Board of Education's goal of Future Ready Schools for the 21st century. The plan focuses on four priorities: (1) updating infrastructure; (2) providing universal access for students and staff to devices; (3) online professional development opportunities for all staff; and (4) a shared services model to reduce redundancies and consolidate systems, applications, and infrastructure.

To fund the plan, the district applied for and received E-rate funding and also sought out alternatives to print-based textbook purchases. Not only is this latter decision cost-effective but it provides students and staff with high-quality, up-to-date resources for learning. Instead of print-based textbooks—which quickly go out of date—the district now uses North Carolina's WiseOwl to access free online resources as well as the University of North Carolina's Learn NC rrepository of learning resources and professional development resources.

Rethink Existing Staff Responsibilities

As part of their technology implementation plans, many districts, schools, and higher education institutions are rethinking the roles and responsibilities of existing staff members to support technology in learning. For example, some are expanding the role of librarians to become evaluators and curators of learning technology resources, an activity that taps into their existing skill sets. Other districts and schools have adopted shared leadership and staffing models, enabling them to expand what they can offer students by sharing expensive resources. Another option for districts and schools is to partner with other organizations to staff specific technology in learning programs. Whatever approach is adopted, organizations are well served to make sure they are fully staffing to meet needs rather than simply adding additional work to existing positions.

BUILDING NONPROFIT PARTNERSHIPS: CODE IN THE SCHOOLS HELPS SCHOOLS BUILD COMPUTER SCIENCE CAPACITY

To increase capacity, schools can partner with organizations to source instructors and provide professional development to build teacher skills and confidence. Many schools in the greater Baltimore area have partnered with Code in the Schools to provide support for their teachers and librarians who wanted to introduce project-based computer science in the classroom by using low-cost equipment, such as Raspberry Pi, Arduino, and Makey Makey, and learning to use free browser-based resources to start teaching code in the classroom by using Scratch, Code.org, and MIT App Inventor.

Some teachers also worked with Code in the Schools to teach video game and app development in their classrooms. For example, Liberty Elementary School Principal Joseph Manko partnered with Code in the Schools to develop a PK–5 computational skills curriculum, conduct professional development for teachers, and provide direct instruction both during the school day in the library's maker space and in the after-school program.

PARKWAY MOBILE MAKERSPACES: EMPOWERING LIBRARIANS AS TECHNOLOGY LEADERS

In 2015, Parkway School District in Chesterfield, MO, launched its Mobile Makerspace project to jumpstart the maker movement. For Parkway, the goals of the project are twofold—empowering the district's librarians as instructional partners and technology leaders while providing opportunities for students to actively use technology in service of their mission to develop students that are capable, curious, caring and confident learners.

As part of its effort to reimagine the role of its school librarians, the district has focused on providing just-in-time training for their librarians on the technologies in each Mobile Makerspace kit and positioning them as technology leaders and instructional partners working with teachers to design curricular connections for each kit.

The Mobile Makerspace project has facilitated increased collaboration between librarians and teachers in Parkway's schools. "By collaborating with their librarians, teachers have been better able to meet the needs of their students by taking instructional risks," says Bill Bass, Innovation Coordinator for Instructional Technology, Information, and Library Media. "It has created opportunities to experience new worlds and learning opportunities that they didn't even know were an option in their classrooms."

The project gives schools an opportunity to experiment with new technologies and prototype their own spaces before making investments in tools or space redesign. Increasingly, schools that have checked out Mobile Makerspace kits are investing in these innovative spaces to provide students the opportunity to develop and enhance their mindsets to learn, collaborate, and innovate in a community setting where curiosity is embraced. Learn more about the Mobile Makerspace project at tinyurl.com/mobilemakerspaces.

CHANGING THE CONVERSATION: SCHOOL LEADERS REIMAGINE ROLE OF A LIBRARIAN

Library leaders from Indian Prairie School District in Aurora, IL are using the Future Ready Librarians Framework to facilitate purposeful conversations about the changing role of the school librarian with fellow teachers, building administrators, support staff, parents and students. The framework draws a direct connection between the skills and expertise of librarians and the strategic goals schools and districts are setting as they transition to personalized digital learning.

"There is a public misconception that the school librarian is no longer needed as districts move toward 1:1 environments," said Dr. Kristen Mattson an Indian Prairie high school librarian. "In taking the Future Ready pledge and adopting the Future Ready Librarians Framework, our school board and administration have made a commitment to school libraries, publically recognizing the valuable skillset that a certified librarian can bring to a school. Our team plays a vital role in supporting staff and students as learning materials go digital and our classroom pedagogies evolve."

After using the Future Ready Librarians Framework as a tool for personal reflection, the district's 32 certified librarians set individual and district team goals aligned to the framework, which building and district administrators have used to inform the professional development and supports offered throughout the year. To share their learning, the district's librarians started a Future Ready Librarians blog featuring stories aligned to the components of the framework, written to help others see how Future Ready ideas translate into action. These stories also help parents, community members, and school board members understand the continued relevancy of the school library.

Ensure Long-Term Sustainability

Technology investments are not onetime expenses. Although one-time grants and other supplemental funding sources can serve as catalysts for establishing technology in learning efforts, they are not sustainable as schools and districts build toward a long-term vision and plan. When devices reach the end of life and infrastructure equipment becomes obsolete, districts and schools should have a reliable means to replace or upgrade them. Leaders should consider technology an ongoing, line-item expense from the very beginning of planning technology implementation.

Recommendations

- **Establish clear strategic planning connections among all state, district, university, and school levels and how they relate to and are supported by technology to improve learning.**
  State and local authorities are uniquely suited to understand the needs and resources available within their local education ecosystems. Broad, coordinated strategic planning requires a commitment from all parties involved to collaborate consistently across organizational boundaries. These conversations and connections need proactive champions who will invest in working at this level and who can take advantage of existing state and regional conferences to further this work.
- **Set a vision for the use of technology to enable learning such that leaders bring all stakeholder groups to the table, including students, educators, families, technology professionals, community groups, cultural institutions, and other interested parties.**
  Although not all parties will be responsible for the execution of a vision for the use of technology to enable learning, by making certain all involved stakeholder groups are part of the vision-setting process, leaders will ensure better community support and the establishment of a plan for learning technology that reflects local needs and goals.
- **Develop funding models and plans for sustainable technology purchases and leverage openly licensed content while paying special attention to eliminating those resources and tasks that can be made obsolete by technology.**
  Rather than viewing technology as an add-on component to support learning, leaders should take stock of current systems and processes across learning systems and identify those that can be augmented or replaced by existing technologies. During the planning process, they also should identify systems and processes for which no replacement currently exists within the district, school, or college and set goals for developing more efficient solutions.
- **Develop clear communities of practice for education leaders at all levels that act as a hub for setting vision, understanding research, and sharing practices.**
  Building on the model of the education innovation clusters, state, district, university, and community organization leaders should establish cohesive communities of practice—in person and online—to create virtuous cycles for sharing the most recent research and effective practices in the use of educational technology.

[1] Lemke, C., Coughlin, E., Garcia, L., Reifsneider, D., & Baas, J. (2009). *Leadership for Web 2.0 in education: Promise and reality.* Culver City, CA: Metiri Group.

[2] Consortium for School Networking. *CoSN's 2015 annual E-rate and infrastructure survey.* (2015). Retrieved from http://cosn.org/sites/default/files/pdf/CoSN_3rd_Annual_Survey_Oct15_FINALV2.pdf.

[3] The full list of resources and literature reviewed in developing the Characteristics of Future Ready Leadership: Research Synthesis is included in Appendix A.

[4] Consortium for School Networking. *CoSN's 2015 annual E-rate and infrastructure survey.* (2015). Retrieved from http://cosn.org/sites/default/files/pdf/CoSN_3rd_Annual_Survey_Oct15_FINALV2.pdf.

[5] Sheninger, E. (2014). *Digital leadership: Changing paradigms for changing times*. Thousand Oaks, CA: Corwin Press.

[6] John Carver. (2015). 2020 Howard-Winn Admin Update. Retrieved from http://2020hwinnadminupdates.blogspot.com/2015/10/jcc-october-16-2015.html?_sm_au_=iVVZSvStrsDP4TqR.

4. Assessment

Measuring for Learning

GOAL: At all levels, our education system will leverage the power of technology to measure what matters and use assessment data to improve learning.

Measuring learning is a necessary part of every teacher's work. Teachers need to check for student understanding, and parents, students, and leaders need to know how students are doing overall in order to help them successfully prepare for college and work. In addition to supporting learning across content areas, technology-enabled assessments can help reduce the time, resources, and disruption to learning required for the administration of paper assessments.[1] Assessments delivered using technology also can provide a more complete and nuanced picture of student needs, interests, and abilities than can traditional assessments, allowing educators to personalize learning.

Through embedded assessments, educators can see evidence of students' thinking *during* the learning process and provide near real-time feedback through learning dashboards so they can take action in the moment.[2] Families can be more informed about what and how their children learned during the school day. In the long term, educators, schools, districts, states, and the nation can use the information to support continuous improvement and innovations in learning.

Technology-enabled tools also can support teacher evaluation and coaching. These tools capture video and other evidence of qualities of teaching such as teamwork and collaboration. They provide new avenues for self-reflection, peer reflection and feedback, and supervisor evaluation.

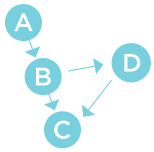
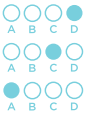
Educators and institutions should be mindful of whether they are measuring what is easy to measure or what is most valuable to measure. Traditional assessments in schools and post-secondary institutions today rely largely on multiple-choice questions and fill-in-the-bubble answers.[3] Many assessments also happen after learning has occurred with results delivered months later, usually after the course has ended. Assessments are more instructionally useful when they afford timely feedback.

Continued advances in technology will expand the use of ongoing, formative, and embedded assessments that are less disruptive and more useful for improving learning. These advances also ensure that all students have the best opportunity to demonstrate their knowledge and skills on statewide assessments that increasingly focus on real-world skills and complex demonstrations of understanding. Statewide assessment—coupled with meaningful accountability—is an essential part of ensuring students have equitable access to high-quality educational experiences. At the same time, it is crucial to focus time and effort on tests worth taking—those that reflect the kind of instructional experiences students need and that provide actionable insight.

As technology gives us the capability to improve long-standing assessment approaches, our public education system has a responsibility to use the information we collect during assessment in ways that can have the greatest impact on learning. This means using assessments that ask students to demonstrate what they have learned in meaningful ways. And students and parents know there is more to a sound education than picking the right answer on a multiple-choice question or answering an extended-response question outside of the context of students' daily lives. All learners deserve assessments that better reflect what they know and are able to do with that knowledge.

FUTURE OF ASSESSMENT

The shift from traditional paper and pencil to next generation digital assessments enables more flexibility, responsiveness, and contextualization.

	TRADITIONAL	NEXT GENERATION
TIMING	 After learning	 Embedded in learning
ACCESSIBILITY	 Limited	 Universally designed
PATHWAYS	 Fixed	 Adaptive
FEEDBACK	 Delayed	 Real Time
ITEM TYPES	 Generic	 Enhanced

Approaches to Assessment

Various types of assessments are appropriate for different uses and at different times. Summative assessments measure student knowledge and skills at a specific point in time. Summative assessments often are administered in common to a group of students, whether an entire class, grade level at a school, or grade level across a district. These assessment results can help to determine whether students are meeting standards in a given subject and to evaluate the effectiveness of an instructional curriculum or model.[4]

Many PK–12 schools administer formal summative tests at the end of the year, which they may augment with interim tests earlier in the year. These assessments provide system-wide data on student achievement as well as data by sub-groups of learners.[5] The data can provide valuable insights regarding the achievement and progress of all students, including efforts to promote equitable access to excellent educational opportunities and to narrow achievement gaps.

In contrast, formative assessments are frequent, instructionally embedded checks for understanding that provide quick, continual snapshots of student progress across time. Formative assessments provide information during the instructional process, before summative assessments are administered. Both teachers and students can use the results from formative assessments to determine what actions to take to help promote further learning. These assessments help identify students' understanding, inform and improve the instructional practice of teachers, and help students track their own learning.[6]

Optimally, a comprehensive assessment system balances multiple assessment approaches to ensure that students, families, educators, and policymakers have timely and appropriate information to support individual learners and to make good decisions to strengthen educational systems overall.

Using Assessment Data to Support Learning

In almost all aspects of our daily lives, data help us personalize and adapt experiences to our individual needs. However, there is much work remaining to realize the full potential of using assessment data to improve learning. One recent study of teacher perceptions of the use of data revealed a range of frustrations with many current implementations. These frustrations include being overwhelmed with large amounts of data from disparate sources, incompatibility of data systems and tools that make data analysis unnecessarily time-consuming, inconsistency in the level of detail and quality of data, and delays in being able to access data in time to modify instruction.[7]

Education data systems do not always maximize the use of interoperability standards that would enable easy and secure sharing of information with educators, schools, districts, states, students, and their families. As a result, educators are missing out on significant opportunities to use data to improve and personalize learning. With improved educational data systems, leaders can leverage aggregate data to improve the quality and effectiveness of technology-enabled learning tools and resources.

For example, it is now possible to gather data during formative and summative assessments that can be used to create personalized digital learning experiences. In addition, teachers can use these data to inform interventions and decisions about how to engage individual students; personalize learning; and create more engaging, relevant, and accessible learning experiences for all learners.

Assessment data can be made available directly to students. When they have access to their data, students can play a larger role in choosing their own learning pathways.[8] The data also can be made available to family members so students' advocates can play a more active role in supporting their children's education. Moreover, data can be used to support teachers' efforts—individually or in teams, departments, or schools—to improve professional practice and learning.[9] For personalized learning systems to reach their full potential, data systems and learning platforms should include seamless interoperability with a focus on data security and issues related to privacy.

In many cases, pre-service teaching candidates do not receive sufficient instruction on understanding and using data. At the same time, in-service teachers can benefit from ongoing professional development on the integration of technology to enhance their teaching. According to the Data Quality Campaign, as of February 2014, just 19 states included the demonstration of data literacy skills as a requirement for teacher licensure.[10] Although data from technology-based assessments and data systems hold great potential, they are meaningful only when educators use them effectively. Teachers deserve ongoing support to strengthen their skills in how to use data to meet the needs of students better.

Addressing these challenges will take a three-pronged approach: (1) preparing and supporting educators in realizing the full potential of using assessment data, (2) encouraging the development of data assessment tools that are more intuitive and include visualizations that clearly indicate what the data mean for instruction, and (3) ensuring the security and privacy of student data within these systems.

For a more complete discussion of student data safety and privacy, see Section 5: Infrastructure.

How Technology Transforms Assessment

Technology can help us imagine and redefine assessment in a variety of ways. These tools can provide unobtrusive measurements for learners who are designing and building products, conducting experiments using mobile devices, and manipulating parameters in simulations. Problems can be situated in real-world environments, where students perform tasks, or include multi-stage scenarios that simulate authentic, progressive engagement with the subject matter. Teachers can access information on student progress and learning throughout the school day, which allows them to adapt instruction to personalize learning or intervene to address particular learning shortfalls. The unique attributes of technology-based assessments that enable these activities include the following.

Enable Enhanced Question Types

Technology-based assessments allow for a variety of question types beyond the limited multiple-choice, true-or-false, or fill-in-the-blank options that have characterized traditional assessments. Examples of enhanced question types include the following:

- Graphic response, which includes any item to which students respond by drawing, moving, arranging, or selecting graphic regions
- Simulations, in which students take action in immersive and/or roleplaying environments to test their knowledge in contexts that provide high fidelity to real world scenarios
- Equation response, in which students respond by entering an equation
- Performance-based assessments, in which students perform a series of complex tasks

Technology-enhanced questions allow students to demonstrate more complex thinking and share their understanding of material in a way that was previously difficult to assess using traditional means.

In particular, performance-based assessments are designed so that students must complete a series of complex skills that ask them to synthesize information from multiple sources, analyze that information, and justify their conclusions. For example, a performance task in English language arts might include reading passages from primary documents, analyzing the set of passages, and writing an essay in response to a prompt. In a mathematics class, a performance task might ask students to analyze a graph based on actual data and describe the linear relationship between the quantities. Because performance-based assessments allow students to construct an original response rather than selecting the right answer from a list, they can measure students' cognitive thinking skills and their ability to apply their knowledge to solve realistic, meaningful problems.[11]

Using the technology offered in performance-based assessments, students can enter their responses in the online interface. For tasks that require hand scoring, scores can be merged with machine-scored items in the same system, thus providing complete test results. For example, the Partnership for Assessment of Readiness for College and Careers and the Smarter Balanced Assessment Consortium evaluate students' ability to excel at classroom speaking and listening assignments in addition to more traditional machine-scored prompts.

Measure Complex Competencies

A recent convening of the National Research Council (NRC) underscored the importance of broadening the focus of assessment to include non-cognitive competencies and the importance of technology in measuring knowledge, skills, and abilities.[12]

As an example, the NRC highlighted the work of the international comparative assessment, Programme for International Student Assessment (PISA). PISA administers a novel technology-based assessment of student performance in creative problem solving designed to measure students' capacity to respond to non-routine situations to achieve their potential as constructive and reflective citizens. The NRC also highlighted the SimScientists simulation-based curriculum unit and assessments, which are designed to use technology to measure middle school students' understanding of ecosystems and scientific inquiry.

Similarly, in June 2015 the National Assessment of Educational Progress (NAEP) announced plans to expand its testing program to begin to include measures of students' motivation, mindset, and perseverance in an effort to build the evidence base for more widespread use.

PISA

PISA is a triennial international survey that aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students. For additional information, visit www.oecd.org/pisa/.

TECHNOLOGY ENABLES ASSESSMENT OF GROWTH MINDSET

With funding from the U.S. Department of Education's Small Business Innovation Research program, Mindset Works developed SchoolKit, an app designed to strengthen academic and social and emotional success. Through animations, assessments, and classroom activities, students learn a growth mindset—the understanding that ability develops with effort. Pilot research in nine middle schools showed significant increases in student growth mindset, which related to increases in learning goals, positive beliefs about effort, and positive academic habits and behaviors (such as resilient responses to failure and better learning strategies).[13]

These changes also related to increases in students' grade point averages. Since launching in 2012, SchoolKit has been used by tens of thousands of students around the country, including all middle schools in Washington, D.C. The app is based on Carol Dweck's research on growth mindsets.[14]

Provide Real-Time Feedback

Technology-based formative assessments can offer real-time reporting of results, allowing stakeholders to understand students' strengths and weaknesses, while guiding them to make valid, actionable interpretations of the assessment data. Such assessments can enable educators to see, evaluate, and respond to student work more quickly than can traditional assessments. Similarly, learners and their families can access this information almost in real time. Technology-based summative assessments also facilitate faster turnaround of results.

Some of today's technology-based assessments also allow for a richer menu of approaches to feedback than do traditional or even first-generation online assessments. Certain formative assessment platforms allow educators to provide feedback to students via in-line comments (through video, audio, or text), engage in online chats, e-mail feedback directly to families and learners, and connect learners to additional resources for practicing specific skills or developing key understandings.

These technologies also can increase the efficiency of the process of giving feedback, allowing educators more time to focus on areas of greatest need. For example, for giving feedback on areas of frequent concern, educators can pre-populate a menu of responses to use as comments, allowing them to shift focus to areas of feedback unique to each student. Automated responses can be generated as well when assignments are late or incomplete. Although this is still nascent technology, in recent years, advances have occurred in automated scoring of essays that may make it a more powerful tool to generate timely feedback.

Increase Accessibility

Advances in technology grounded in UD and systems that align to UDL have made assessments more accessible and valid for a greater number of students, including those with diverse abilities and language capabilities. These advances have allowed a greater proportion of the population access to assessments.

Special features include the ability to increase font sizes and change color contrast, text-to-speech, bilingual dictionaries, glossaries, and more. These features can be embedded in assessments and made available to students, depending on what the assessment is measuring and identified learner needs. Seamless accessibility features embedded in technology-based assessments reduce the need to single out individual students for extra supports, providing an added benefit for students and educators alike.

Similarly, assistive technology, such as text-to-speech, alternate response systems, and refreshable braille, supports students with disabilities in accessing learning. These technologies continue to advance and can make it possible for students to interact with digital learning resources in ways that would be impossible with standard print-based assessments. When both assistive technologies and assessments effectively interoperate, students are better able to demonstrate what they know and how to apply this knowledge.

Adapt to Learner Ability and Knowledge

Computer adaptive testing has facilitated the ability of assessments to estimate accurately what students know and can do across the curriculum in a shorter testing session than would otherwise be necessary. Computer adaptive testing uses algorithms to adjust the difficulty of questions throughout an assessment on the basis of a student's responses. For example, if the student answers a question correctly, a slightly more challenging item is presented next; if the student answers incorrectly, he or she receives another opportunity to demonstrate knowledge in a different manner.

Because adaptive tests target content and test items aligned with each student's ability level, the adaptation leads to more precise scores for all students across the achievement continuum in a greatly reduced time period. Achieving the same level of precision in a traditional paper-and-pencil test would require students to answer many more questions, potentially impacting instructional time. Moving forward, these assessments can benefit from increased interoperability so that the data from these adaptive measures can be pulled into a centralized dashboard that allows a more integrated understanding of student performance.

Embedded w ith the Learning Process

Embedded assessments are woven directly into the fabric of learning activities students undertake. Such assessments may be technology driven or simply a part of effective instruction, and they may appear in digital learning tools and games. They are generally invisible to the instructional process because they are embedded in the regular classroom activities. Embedded assessments have the potential to be useful for diagnostic and support purposes in that they provide insights into why students are having difficulties in mastering concepts and provide insights into how to personalize feedback to address these challenges.[15]

Game-based assessment is designed to leverage parallels between video game design and next-generation learning and assessment.[16] Recent research has focused on promising ways that digital learning can support formative assessment practices[17,18]—including wraparound features such as annotation tools and dashboards—and ways that games can identify more nuanced conclusions about student learning outcomes.[19]

INCORPORATING STUDENT INTERESTS: GAMES AND ASSESSMENT

GlassLab creates and supports high-impact games that make learning visible by creating games, conducting research, and building infrastructure that lowers entry costs for new developers. For example, GlassLab has conducted a number of studies investigating the efficacy of games as a tool for learning and unobtrusive assessment.

Students using GlassLab's games regularly report that they persist in the face of challenging academic content in the games and that they feel ownership over their learning. SimCityEDU: Pollution Challenge!, one of GlassLab's digital games, provides educators with the tools and content to engage students in real-world challenges faced by countries globally. The game focuses on the countries' need to reduce dependence on cheaper, pollution-generating resources such as coal while at the same time growing their economies.

In SimCityEDU: Pollution Challenge!, students play the role of a city mayor faced with a growing pollution problem and a shrinking economy. While learning how economic and environmental issues influence one another, students are assessed on their ability to problem-solve and understand relationships in complex systems. The GlassLab assessment system gathers evidence for students' problem-solving and systems-thinking skills unobtrusively in the course of students' gameplay by logging student activities. To support teacher facilitation, and enrich teacher-student interactions, the game also includes lessons plans, teacher and student dashboards, and student data reporting.

EMBEDDING ASSESSMENT: UNDERSTANDING MIDDLE SCHOOL STUDENTS' KNOWLEDGE OF PHYSICS CONCEPTS

Valerie Shute, the Mack and Effie Campbell Tyner Endowed Professor in Education at Florida State University, is studying the impact of video games on learning, with a focus on building a greater understanding of the future of embedded assessment.

One study conducted by Shute and her colleagues of middle school students focused on the acquisition and embedded assessment of physics concepts by having students play the relatively simple video game, Newton's Playground. Players guide a ball to a balloon across a set of increasingly challenging two-dimensional environments involving the placement and manipulation of ramps, pendulums, levers, and springboards. After taking a traditional pre-test and answering a background questionnaire to assess prior knowledge, students played the game during six class periods—about four hours in total—and concluded their participation by completing a traditional post-test.

Newton's Playground generates detailed log files as students play, capturing data such as time spent on the level, number of restarts of the level, total number of objects used in a solution attempt, whether the solution ultimately worked, and the trajectory of the ball. Each of these data points provides information that the game uses to make inferences about how well each student is doing in the game and to gauge the student's current understanding of the physics concepts being taught.

On the basis of analyses of the pre- and post-test data, game log files, and the background questionnaire, Shute and her colleagues demonstrated the following:

- Students playing the game improved their conceptual physics understanding.
- Students who were more engaged in playing the game learned more than those who were less engaged.
- The assessments embedded in the video game could be used to substitute for the traditional assessments commonly used in today's classrooms.

Shute's work underscores the potential for embedded assessment to play an increasingly important role in helping students to gain and demonstrate mastery of important knowledge, skills, and abilities.[20]

Assess for Ongoing Learning

Technology provides students with multiple pathways to create assessable work throughout the year. To demonstrate their understanding, students can create multimedia productions, construct websites to organize and analyze information, and design interactive presentations to serve as products for assessment. These pathways allow teachers to understand how students access and understand information across given categories. For students who need individual accommodations, advances in technology allow for dynamic and personalized presentation and assessment using alternative representations of the same concept or skill. For example, alternative text can be provided for images through the work of the Diagram Center to make graphics accessible to learners with print disabilities.

Moving forward, increasingly sophisticated technology-driven assessments will enable more powerful personalized learning, likely accelerating the shift from time-based learning to competency-based learning.

The Future of Technology-Based Assessment

Although the process is often challenging, in many places, transitioning to technology-based assessment is well under way. Such assessments will continue to improve across time in the following ways.

Continuous Improvement of Assessments

Traditional paper-and-pencil tests, and even some first-generation technology-based assessments, usually are reviewed and updated only on a designated schedule, often driven by printing and distribution cycles rather than when test items need to be updated. Online delivery of assessments allows for continuous improvement of test items.

Integrated Learning and Assessment Systems

Technology has the potential to move assessment from disjointed separate measures of student progress to an integrated system of assessments and personalized instruction to meet the needs of the learner. Technology can integrate more fully student classroom experiences, homework assignments, and formative and summative assessments, all of which are tied closely to academic standards. Online learning platforms can display effects of missing assignments, progress toward goals, and channels for communication with mentors and teachers.

We also should expect to see integrated systems that make the learning process more seamless for students and educators. As students progress along personalized learning pathways, they will be assessed when they are ready to demonstrate mastery over particular skills and content rather than when the calendar indicates there is a testing date. At the same time, we have a responsibility to ensure that all students are held to high standards and offered excellent educational experiences. Ensuring equity while also providing accelerated personalization is the one of the greatest challenges and opportunities moving forward for technology in assessment.

Using Data Effectively and Appropriately

To realize the vision of sharing data across student information systems, we need to address several challenges. On the technical front, formidable barriers to the development of multi-level assessment systems are created by having several student data systems running side-by-side, coupled with disparate data formats and the lack of interoperability across systems. Student and program data today are collected at various levels and in various amounts to address different needs in the educational system. State data systems generally provide macro solutions, institution-level performance management systems offer micro solutions, and student data generated by embedded assessments create nano solutions. Providing meaningful, actionable information that is collected across all of these systems will require agreement on the technical format for sharing data while attending to student privacy and security.

To assist with overcoming these challenges, the National Center for Education Statistics at the U.S. Department of Education has been leading the Common Education Data Standards (CEDS) Initiative, a national, collaborative effort to develop voluntary, common data standards. The CEDS Initiative's objective is to help state and local education agencies and higher education organizations work together to identify a minimal set of key data elements common across organizations and come to agreement on definitions, business rules, and technical specifications to improve the comparability of and ability to share those elements. (Note: Version 5 was released in January 2015.)

For more information on protecting student data and privacy, see Section 5: Infrastructure.

Learning Dashboards That Enable Visualizations

Although systems that support real-time feedback can increase educator and learner understanding of progress toward learning goals, the feedback is even more valuable if it is available in one easily accessible place. To achieve this, we need to connect information about learning that happens across digital tools and platforms.

Learning dashboards integrate information from assessments, learning tools, educator observations, and other sources to provide compelling, comprehensive visual representations of student progress in real time. A learner's attendance data, feedback from instructors, summative evaluation data, and other useful information all can be made available in formats specific to different stakeholders. Learning dashboards can present this data in easy-to-understand graphic interfaces.

These dashboards also can offer recommendations about resources to help students continue their learning progression as well as help identify students who may be at risk of going off track or even dropping out of school. Across larger education systems, these dashboards can help educators to track learner performance across time as well as monitor groups of students to identify shifts in equity, opportunity, and achievement gaps. Although teacher dashboards are becoming commonplace, student and family dashboards can offer promising opportunities to help students take control of their own learning.

PUTTING LEARNING ON DISPLAY: SUMMIT HILLS PUBLIC SCHOOLS' STUDENT DASHBOARDS PERSONALIZE LEARNING

Each morning, students at Summit Public Schools connect to their Personalized Learning Plans (PLP) by using their devices. Here, students find both their short-term and long-term project views, the materials they need to complete their projects, and just-in-time formative feedback to improve their individual learning, all in one location. Using a color-coded system, each project is linked explicitly with the associated content knowledge standards, and students can see the progress they have made toward those standards as well as areas in which they need more practice. Summit Public Schools invited 19 other schools to try out the PLP through a program called "Summit Basecamp." Educators at partner organizations are given opportunities to explore in-depth the capabilities of the PLP and are provided additional resources to develop a personalized learning environment in their schools.

This automated feedback and work management system gives students easy access and greater control over their learning and frees educators to spend more time teaching and less time on administrative and organizational tasks. "It was really difficult to track where my students were on their progress towards meeting a learning objective and giving them timely feedback," says Elizabeth Doggett, a teacher at Summit Public Schools. "Often I would take student work home over the weekend, but by the time I got through giving them all feedback, it would be too late for them to make meaningful changes."[21]

With the Personalized Learning Plan system, students have the formative feedback they need in real time, and their educators, such as Doggett, are able to plan and execute differentiated instruction more efficiently and effectively so that all of her students can succeed. Students also are benefiting individually from the student-facing side of the Personalized Learning Plan. Educators have taken notice of how these plans promote student agency and motivation. "Students should be able to access what they need at the moment they need it, and we provide the resources so that they can do that," says Jon Deane, the former chief information officer of Summit Public Schools.[22]

Doggett sums up the effect of implementing the Personalized Learning Plan, saying, "It makes the students' lives so much easier. It makes me a better teacher, and it makes them more successful students."[23]

Set of Shared Skill Standards

As we shift toward personalized learning, there is increased need for a shared set of common skill standards. The development of micro-credentials is one approach to address this need by creating a shared language and system for communicating success in developing these competencies.

Micro-credentials, often referred to as badges, focus on mastery of a singular competency and are more focused and granular than diplomas, degrees, or certificates. The earning and awarding of micro-credentials typically is supported by a technology-based system that enables students and evaluators to be located anywhere and for these activities to take place everywhere and all the time. Micro-credentials also allow for the portability of evidence of mastery. Information about the student's work that earned a badge can be embedded in the metadata, as can the standards the work reflects and information about the awarder of the badge. As with other data systems, a key goal for the next generation of micro-credentialing platforms is interoperability with other educational information systems.[24]

RECOGNIZING DIGITAL LITERACY SKILLS: ASSIGNING MICRO-CREDENTIALS

LearningTimes, in partnership with the New York Department of Education's Office of Postsecondary Readiness, has developed DIG/IT, a digital learning course that introduces students in transfer schools (second-chance high schools) to digital literacy skills while they develop their plans for college, careers, and life after high school. DIG/IT is an open standards-based system designed specifically for badge-empowered social learning that uses challenge-based quests and badges to recognize competencies and positive behaviors in four areas: digital citizenship, college and career explorations, financial literacy and arts, culture and games. At the end of the course, students design a learning experience for a family member or another important person in their lives.

Upon completing a series of related quests, students earn badges acknowledging tangible new skills they have acquired. They also earn reward badges for contributions to the online and classroom community. As they gather enough rewards, they "level up" and continue to earn rewards for participating in the community and for helping others.

DIG/IT is currently in use in 36 New York City transfer schools. The initial pilot has had promising results, including positive teacher and student feedback and reportedly higher levels of student engagement in school. Student attendance in the DIG/IT- based course has been higher than in courses not using the approach. The DIG/IT program will be rolled out to approximately 50 transfer schools over the next two years, reaching more than 5,000 students.

Since DIG/IT's development, LearningTimes has spun off Credly to focus on earning, managing, and analyzing digital credentials and badges in an open and portable way. Credly hosts more than 6,000 organizations and their respective micro-credential initiatives. BadgeOS, the open source environment for setting up progressive credentialing programs, has been installed more than 30,000 times by organizations around the world and supports millions of learners.

Educators also can benefit from earning micro-credentials because they can gain recognition for new discrete skills they learn throughout their careers. Nonprofits such as, Digital Promise and Friday Institute, have developed an educator micro-credentialing system, noting that educator micro-credentials can identify, capture, recognize, and share the practices of our best educators. Proponents view micro-credentials as a promising emerging professional development strategy.

Recommendations

- **Revise practices, policies, and regulations to ensure privacy and information protection while enabling a model of assessment that includes ongoing gathering and sharing of data for continuous improvement of learning and teaching.**
  This will require not only greater systems interoperability standards but also increased capacity on the part of educators and administrators to understand the types of systems they want to establish within schools and colleges. In addition, they will need to have an understanding of the standards of interoperability they should demand from vendors. A key component of this increased capacity should ensure educational leaders have a firm understanding of privacy and security concerns, how those concerns are addressed within the school or system, and clear communication of policies and procedures with all stakeholders. Achievement of this recommendation would benefit from the involvement and guidance of organizations, such as CoSN, ISTE, and the State Educational Technology Directors Association (SETDA), that have developed specialized expertise in these areas.

- **States, districts, and others should design, develop, and implement learning dashboards, response systems, and communication pathways that give students, educators, families, and other stakeholders timely and actionable feedback about student learning to improve achievement and instructional practices.**
  The next generation of such tools should integrate across platforms and tools seamlessly, be designed with a mobile-first mindset, and be guided by UD and UDL principles to ensure accessibility by all stakeholders. Although current products and dashboards include basic functionality and features that improve on those of their predecessors, future iterations should be built on a premise of feedback and conversation, allowing learners and families to discuss learning outcomes and evidence and increasing agency and ownership across stakeholder groups.

- **Create and validate an integrated system for designing and implementing valid, reliable, and cost-effective assessments of complex aspects of 21st-century expertise and competencies across academic disciplines.**
  Interoperable formative assessment formats offered by major testing consortia for use by educators throughout the year are an important first step. However, work remains to ensure more educators have access to high-quality formative assessment tools and to develop additional capacities to assess both cognitive and non-cognitive skills better. Moving forward, increasing educator capacity for the design and deployment of valid and reliable formative assessments will require the concerted efforts of current assessment developers, teacher preparation programs, school systems, and researchers. Furthermore, colleges and universities will benefit from system-wide reviews of assessment practices and from ensuring all faculty have deep understandings of key principles and practices surrounding the design and implementation of effective learning assessments.

- **Research and development should be conducted that explores how embedded assessment technologies such as simulations, collaboration environments, virtual worlds, games, and cognitive tutors can be used to engage and motivate learners while assessing complex skills**
  Although some of this research is in its early stages, the way forward will require close collaboration among organizations—such as GlassLab, Games for Change, and iCivics; colleges, universities, informal learning spaces, and schools; philanthropic organizations; and research institutions—that have a deep understanding of how game mechanics increase learner motivation. This collaboration can increase the likelihood of effective and engaging experiences being built to support learning.

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5. Infrastructure

Enabling Access and Effective Use

GOAL: All students and educators will have access to a robust and comprehensive infrastructure when and where they need it for learning.

Preparing students to be successful for the future requires a robust and flexible learning infrastructure capable of supporting new types of engagement and providing ubiquitous access to the technology tools that allow students to create, design, and explore. The essential components of an infrastructure capable of supporting transformational learning experiences include the following:

- **Ubiquitous connectivity.** Persistent access to high-speed internet in and out of school
- **Powerful learning devices.** Access to mobile devices that connect learners and educators to the vast resources of the internet and facilitate communication and collaboration
- **High-quality digital learning content.** Digital learning content and tools that can be used to design and deliver engaging and relevant learning experiences
- **Responsible Use Policies (RUPs).** Guidelines to safeguard students and ensure that the infrastructure is used to support learning

Building a robust infrastructure for learning begins with an understanding of the goals and desired outcomes that support engaging and empowering learning experiences. When based on learning goals, technology infrastructure decisions become clear.

INFRASTRUCTURE

To Support Everywhere, All the Time Learning

SETTING FUTURE GOALS: GUIDANCE ON ASSESSING YOUR CURRENT SITUATION

These questions address many of the important considerations for districts as they begin the development of a comprehensive plan for learning with technology. More detailed information and guidance can be found in the U.S. Department of Education's Future Ready Schools: Building Technology Infrastructure for Learning.

- What is your vision for learning that the technology infrastructure will be supporting?
- What digital learning content, tools, and resources will be supported?
- How many and what types of devices will be supported?
- What kind of professional development will teachers need to become proficient with digital learning?
- What is your current network capacity?
- What is the current state of your physical infrastructure?
- What resources are available to fund this transition?

DEVELOPING A MULTI-YEAR APPROACH: BALTIMORE COUNTY PUBLIC SCHOOL DISTRICT'S (BCPS) COMPREHENSIVE PLAN FOR LEARNING WITH TECHNOLOGY

To achieve its goal of ensuring that every school has an equitable, effective, digital learning environment and that all students and teachers have the personal technology they need to participate fully in connected learning, BCPS has developed and is implementing the Students and Teachers Accessing Tomorrow (S.T.A.T.) initiative.

S.T.A.T. is a multi-year plan for the transformation of BCPS that includes the following eight conversions:

1. **Curriculum.** BCPS teachers are creating a digitally enhanced curriculum that redefines how to deliver instruction in a learner-centered, blended learning environment while raising expectations and that places greater emphasis on critical thinking and analytical skills..
2. **Instruction.** All BCPS teachers will facilitate learning that includes the use of technology where appropriate. BCPS One, a fully integrated technology platform that brings together all of the district's programs and initiatives, offers a single interface for students and teachers to access blended curriculum content, including digital resources for teaching and learning.
3. **Assessment.** BCPS One will give teachers the ability to access and administer curriculum-aligned formative and summative assessments easily, as well as access a system-wide grade book, with real-time access for students and parents.
4. **Organizational Development.** Intensive job-embedded professional learning opportunities continue in the initiative's 10 pilot Lighthouse Schools, which serve as model demonstration sites with a Teacher Leader Corp turning their classrooms into learning labs.
5. **Infrastructure.** BCPS currently is updating its infrastructure to support S.T.A.T. by issuing mobile devices to instructional staff and students and by updating networks to ensure all schools are fully wireless. In addition, BCPS has partnered with the Baltimore County Public Library system to enable students to access the BCPS network in any county library.
6. **Policy.** Current BCPS policies are under review and revision to reflect a systematic shift in language that emphasizes empowering students and staff over mandating rules.
7. **Budget.** The significant changes necessary within BCPS to engage a growing and diverse student population and prepare students for college, career, and life will require substantial financial investment.
8. **Communication.** BCPS uses several communication outlets to provide information regarding S.T.A.T., including district and school websites, newsletters, social media, BCPS-TV, and Parent University.

In February 2015, the Johns Hopkins Center for Research and Reform in Education released a 2014 mid-year evaluation of the S.T.A.T. initiative's impact on the 10 pilot Lighthouse Schools.[1] Although the report contains early baseline data, findings suggest that these schools are beginning to reflect the goals of S.T.A.T.

PLANNING FOR THE FAST TRACK: TECHNOLOGY IMPLEMENTATION IN VANCOUVER PUBLIC SCHOOLS

In 2013, voters in the Vancouver Public School District, which serves more than 23,000 students in Vancouver, Washington, passed a $24 million technology levy after a community outreach and awareness campaign under the leadership of Superintendent Steve Webb. The levy eased one of the greatest challenges of a digital learning implementation—how to pay for it. It also put pressure on the district to develop and execute a plan that would have an impact quickly.

As one teacher put it, the district rapidly went from "totally analog, creating notes pages for students on overhead projector transparencies, to laptops for all teachers to a technology deployment that today equips every student and teacher with a tablet."

Central to the implementation were the values of equity and excellence. From the outset, the district viewed technology as a means to close achievement gaps between high-need, underserved student populations and historically higher performing students.

Equipping every student with a tablet was motivated by student learning needs. Crucial to the implementation plan are a number of pilot programs, focused on serving the unique needs of different populations, currently underway in selected schools. English language learners received devices and other digital tools equipped with translation and language development software.

To extend learning beyond the confines of the school day, and to bridge the digital divide in communities and homes across Vancouver, the district also is outfitting school buses with wireless internet and creating hot spots at community centers and other anchor community locations such as neighborhood churches.

Ubiquitous Connectivity

Reliable connectivity, like water and electricity, is foundational to creating an effective learning environment. Students and teachers cannot take advantage of the opportunities to connect and engage globally or leverage high-quality learning resources without consistent and reliable access to the internet. In addition, the U.S. Department of Education's Office for Civil Rights issued a Dear Colleague letter in October 2014 that included access to technology as an important component of equity of access within U.S. schools.

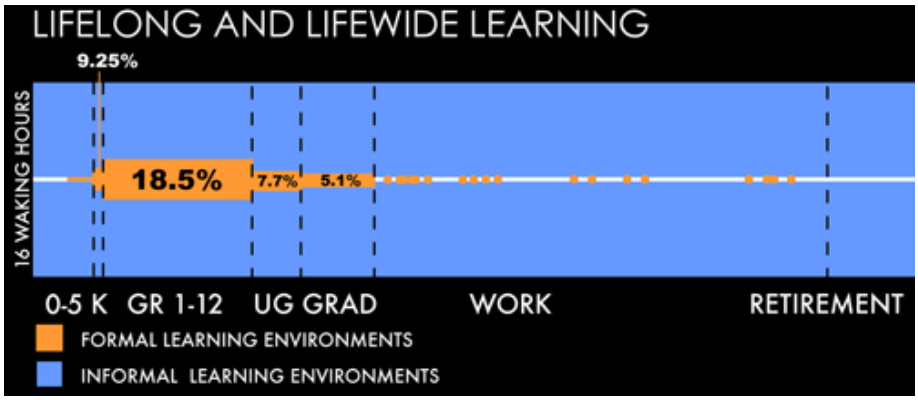
Connectivity at School

In 2013 the White House set a goal for 99 percent of students in the country to have internet access at a minimum of 100 megabits per second per 1,000 students, with a target speed of one gigabit per second by 2018. Efforts by federal, state, and local institutions in recent years have made huge strides toward this goal. The modernization of the E-rate program in 2014 provided billions of additional dollars to help districts improve the speed of and access to Internet connectivity.

Although unprecedented resources are available to reach this goal, still significant work remains for many schools and districts. As mentioned earlier, the 2016 Consortium for School Networking (CoSN) Annual E-rate and Infrastructure Survey found that 81 percent of school systems have met this FCC short-term goal of 100 megabits per second of Internet bandwidth per 1,000 students, which leaves 19% of schools that will need access. Although we still have progress to make, this is a significant improvement from 2013 when only 19 percent reached the goal in 2013.[2] Organizations, such as EducationSuperHighway and CoSN, are committed to supporting schools throughout this transition.

Connectivity at Home

Learning does not stop at the end of the school day, and access to digital learning resources should not either. According to a report from the Council of Economic Advisers, approximately 55 percent of low-income children under the age of 10 in the United States lack internet access at home.[3]



The LIFE Center's Lifelong and Lifewide Diagram by LIFE Center is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0. (LIFE Center: Stevens, R. Bransford, J. & Stevens, A., 2005)

These statistics along with consideration of the amount of time spent out of school have given rise to concerns about a "homework gap" between students whose internet connections at home are slow or non-existent—a problem disproportionately common in rural and underserved communities—and those who have home connections with adequate speed. They also give credence to the view that connectivity at home for students is an essential component of a 21st century education—not something merely nice to have—if we are to avoid exacerbating pre-existing inequities in unconnected homes.[4]

Educational leaders should work to ensure learners have access to connectivity and devices when they leave school grounds so that they are not limited in their ability to experience high-quality connected learning fully. To support schools in this effort, organizations such as EveryoneOn focus on providing highly subsidized Internet access to low-income households. In addition, the U.S. Department of Housing and Urban Development launched ConnectHome in 2015 to focus on bringing high-speed Internet to low-income communities so everyone can participate in our increasingly connected society.

CONNECTHOME

ConnectHome is a U.S. Department of Housing and Urban Development program focused on increasing access to high-speed Internet for low-income households. The pilot program, launched in 27 cities and one tribal nation in the summer of 2015, is aimed at providing thousands of public housing families with high-speed internet access. As part of the program, Internet service providers, nonprofits, and the private sector will offer broadband access, technical training, digital literacy programs, and devices for residents in assisted housing units.[5] For more information, visit **http://connecthome.hud.gov/**.

BRINGING CONNECTIVITY TO THE POOREST COMMUNITIES: COACHELLA VALLEY, CA

When Coachella Valley Unified School District made the decision to implement a plan to transform learning through technology, the plan's architects quickly realized that round-the-clock access to high-speed Internet was essential to create connected learning opportunities in and outside of school. However, because of broad socio-economic diversity in the district, equity of access was a challenge.

Geographically, the district draws from Riverside County, California, and serves the city of Coachella, the community of Thermal, portions of the city of Indio, and Salton City in Imperial County, educating more than 18,000 students across 25 schools. The local cable company refused to run fiber through Native American reservations in the area or through a local mobile home park, leaving some of the district's highest need students on the outside looking in when the school day ended.

To answer the challenge, the district equipped 100 of its school buses with wireless Internet routers with rooftop solar panels to supply power. This enabled students to connect to the Internet on the way to and from school and while traveling to sporting events and extracurricular activities. In addition, at night the Wi-Fi–equipped fleet parked in some of the poorest areas of the district, making high-speed Internet available to students virtually anytime and anywhere.

The initiative was not without challenges. Leadership needed buy-in from the community and the teachers' union, whose members draw salary and benefits from the same general fund. District leaders obtained community buy-in through high-touch outreach that included committee meetings and focus groups as well as speaking directly with or sending e-mail to individual community members. Superintendent Darryl Adams focused on building a bridge between the vision of success that everyone deeply desired for the district's students and the concrete means to realize that vision.

Buoyed by the success of this initiative, Coachella Valley now has a long-term plan for the district to become its own Internet service provider, breaking its dependence on commercial telecom companies.

BRINGING BROADBAND TO NEW COMMUNITIES: OKLAHOMA CHOCTAW NATION TRIBAL AREA CREATES PUBLIC-PRIVATE COLLABORATION

Because of the high cost of installing and maintaining the infrastructure required for high-speed connectivity, many sparsely populated areas of the country lack access to the Internet, widening the digital divide for people living in rural areas. The Choctaw Nation Tribal Area has demonstrated how—through a combination of grants, loans, and donations—private industries can bring critical access to these underserved communities.

In 2009–10, Pine Telephone, the service provider offering voice, video, cell, long-distance, and high-speed broadband in southeastern Oklahoma applied for and received four American Recovery and Reinvestment awards totaling $56 million to build the infrastructure to provide Internet access to the 10 unserved counties encompassed by the Choctaw Nation.[6]

Prior to this investment, the Choctaw Nation Tribal Area lacked access to reliable broadband service. The low population density (8.3 to 19.7 people per square mile), the high poverty rate (25 percent of the population below the poverty line), and the rugged terrain made the economics of broadband infrastructure very challenging. Initial capital costs to deploy broadband meant that broadband service was limited to commercially viable areas.[7]

Today, more than 1,700 customers have access to high-speed connectivity over both fiber and wireless networks, as does every school in the Pine Telephone service area. One district, Broken Bow School District, has been able to use digital devices, online lesson plans, and supplemental online programming.

Family engagement in the Broken Bow School District has improved because parents have online access to records of attendance, assignments, and test scores. The connectivity also allows the Choctaw Nation to multicast educational videos and share messages from tribal leadership from a central location. For example, the School of Choctaw Language now offers distance learning courses to approximately 14 Head Starts and 35 high schools within the Choctaw Nation, in addition to several universities.[8]

TAKING SERVICE EVERYWHERE: TEXAS LIBRARY GOES ALL DIGITAL

The librarians at BiblioTech, an all-digital public library in San Antonio, Texas, are interested in how they can leverage their digital status to serve local communities better where a deep divide exists between those who have access to the Internet and those who do not.

Accredited as a state library in Texas, BiblioTech operates under the belief that, "[If] a digital library can go anywhere, it should go everywhere."[9] In an area where 78 percent of library patrons' homes are without Internet access, the library has distributed 10 eReading devices to five schools within the local school district with the greatest need. Schools quickly recognized the value of these resources and matched or exceeded the number of eReaders in circulation as part of their school library collections.

Within the walls of BiblioTech's physical spaces, users will find eReaders for loan, computers for research, reading and story time for younger readers, and community education courses through partnerships with other local organizations. Because all of the content is stored on the eReading devices the library has for circulation, librarians now spend their time assisting patrons with accessing information, resources, and content.

In addition, because BiblioTech branches require only 2,100 square feet of space, the library is able to co-locate within local public housing developments to put resources and connectivity within reach of patrons who might otherwise be cut off from its collections. Opened in September 2013, BiblioTech has an outreach team that is working to make community presentations in every school in the 14 local districts.

ENSURING ACCESS IN ALL SPACES: INDIANA GIVES INCARCERATED JUVENILES INTERNET FOR LEARNING

Incarcerated youth attend schools typically not equipped with access to the Internet, making it difficult for teachers to use digital learning materials. Similarly, students are unable to access the vast array of digital learning experiences and resources that are increasingly available to other students.

Attempts to address this problem by providing teacher-only access to Internet-enabled interactive whiteboards served only as a halfway measure in that many Internet sites still were blocked from Internet Protocol addresses emanating from juvenile correctional facilities.

In June 2014, the U.S. Department of Education and the U.S. Department of Justice issued a letter to state departments of education and state juvenile justice agencies stating that incarcerated youth need to have the same educational opportunities as those of their non-system-involved peers.[10]

As a result, Indiana approached American Prison Data Systems, a public benefits corporation based in New York City that offers a private network, to determine whether the technology solution it offered through its secure wireless tablets would work inside Indiana's juvenile correctional system. Digital content is delivered via a special secure wireless connection. Students do not reach out and access content from the Internet; instead, approved content is delivered to the student via the secure connection.

In collaboration with Oakland City University, the Indiana Department of Correction implemented a pilot project using American Prison Data Systems secure wireless tablets at the Madison Juvenile Correctional Facility located in Madison, Indiana. Each girl in the facility receives a tablet for use during and after school hours. This pilot project also involved 10 entertainment tablets, which were loaded with movies, games, and music and used as incentives for youth who met their behavior goals.

The project began in late September 2014, with positive preliminary results, including a reduction in the number of negative incidences occurring in the living units, a reduction in grievances and acting-out behaviors as a result of students being able to send easily monitored messages to adults, significant interest in accessing content via tablets, and a reduction in idle time among the girls.

Powerful Learning Devices

Any effort to leverage the power of mobile learning devices and resources is dependent on access to high-speed connectivity. Selecting appropriate devices depends in large measure largely on the age of the students, their individual learning needs and the types of learning activities that will be ongoing in the classroom or after school program. Schools should provide students with appropriate learning devices. The U.S. Department of Education's Office of Educational Technology (OET) published *Future Ready Schools: Building Technology Infrastructure for Learning* in November 2014 to help schools and districts consider device purchases as well as other infrastructure concerns when building technology systems to support learning.

Beware of Bring Your Own Device (BYOD) or Bring Your Own Tech (BYOT)

Many institutions have BYOD or BYOT policies that permit students to use their own mobile devices at school. Although it is certainly reasonable to allow students to learn and communicate using their own devices, there are serious digital equity considerations that should be taken into account if schools use BYOD as their primary method for ensuring students have devices, including the following:

Economic disparity. The ability to access digital learning resources is distributed disproportionately to students whose families can afford the devices. This can widen the very gaps that technology is capable of closing. This situation also may raise legal concerns because schools are expected to provide a free education for all students.

Instructional burden. It can be very difficult for teachers to manage learning experiences and activities when they have to support multiple platforms and device types, and some activities may be incompatible with some devices. In this situation, teachers may revert to activities of the lowest common denominator that work on older and less robust devices at the expense of a more effective learning experience.

Privacy and security. Student-owned devices may not have appropriate safeguards in place for storing their learning data. In addition, personal devices likely will not have the security features required to provide valid assessment.

High-Quality Digital Learning Content

Schools and colleges need to ensure students have access to a variety of high-quality digital learning materials and resources to support their learning. The ability to curate and share digital learning content is an important component of a robust infrastructure for learning.

#GOOPEN

In October 2015, the Office of Educational Technology launched #GoOpen, a national movement that encourages states, school districts and educators to use openly licensed educational materials to transform teaching and learning. Openly licensed educational resources have enormous potential to increase access to high-quality educational opportunities in the United States. Use of openly licensed educational materials has enabled school districts to empower teachers and repurpose a portion of funding typically spent on static textbooks for other pressing needs, such as investing in the transition to digital learning. In January 2017, there are over 100 school districts and 19 states that have committed to support the transition to using high-quality, openly licensed educational resources in their schools.

In February 2016, the Department organized the first ever national #GoOpen Exchange where districts shared best practices and several states launched state-wide initiatives to support districts in their transition to openly licensed educational resources. In June 2016, the Department released the #GoOpen District Launch Packet, the first guide for strategically adopting and maintaining openly licensed educational resources as an integral part of the curriculum plan for the district. Finally, in July 2016, OET developed the #GoOpen Regional Summit in a Box for #GoOpen Districts to host and organize regional summits and facilitate sharing best practices and strategies for using openly licensed educational resources. Three Summits were held in 2016, reaching 425 participants representing over 80 districts. Five more are scheduled to take place in the Spring and Summer of 2017.

Openly Licensed Educational Resources

One of the most effective ways to provide high-quality digital learning materials at scale is through the use of openly licensed educational resources. These resources may be used, modified, and shared without paying any licensing fees or requesting permission. Open licenses for this purpose have been created by organizations such as Creative Commons for learning resources. For software, a number of open license types are available, such as the GNU General Public License and others recognized by the Open Source Initiative or the Free Software Foundation. This is significant considering that the United States currently spends approximately $8 billion each year purchasing commercial learning resources.[11] Replacing just one textbook for one subject can free up tens of thousands of dollars for other purposes.

There are advantages other than just cost savings. Openly licensed materials can be more accurate than traditional textbooks because they can be updated continually as content changes. Openly licensed materials also allow teachers to exercise their own creativity and expertise so they can tailor learning materials to meet the needs of their students.

Nineteen states have committed to providing a statewide repository to help teachers access, curate, refine, and share openly licensed learning resources. In addition, the U.S. Department of Education's Federal Funding for Technology Dear Colleague letter states that Title II funds can be used to prepare teachers to create, use, and share openly licensed digital learning resources. Student Support and Enrichment (SSAE) funds may also be used for similar purposes as indicated in the guidance released in October 2016 by the U.S. Department of Education.[12]

Platforms and organizations such as Illinois Open Educational Resources, CK-12.org, SkillsCommons.org and OER Commons are designed specifically for teachers to locate open content and adapt it, as needed, for their students.

TEACHERS MAKE IT HAPPEN: CORONADO UNIFIED SCHOOL DISTRICT

Coronado Unified has been using openly licensed educational resources to create both core and supplemental instructional materials for four years. The district has found that creating quality resources takes a like-minded, motivated team of educators and dedicated hours of curating and revising the resources into usable tools for instruction. The district is fortunate to have teachers willing to do this rigorous work. Contributions include creating the sources, integrating them into existing instructional materials, and updating them annually. The district remunerates teachers for this work, which open resource experts estimate at about one third of the cost of adopting static, traditional resources.

In addition to financial rewards, a significant benefit to teacher-writers of openly licensed educational resources is the professional development inherent in evaluating resources for alignment with standards, assessments, and exemplary instructional practices, as well as alignment between members of the department or grade level who create the materials.

The district plans to continue promoting the use of the resources as a means to provide up-to-date instructional materials and professional development for teachers.

MAKING OPEN MEAN EVERYONE: UNIVERSITY OF MARY WASHINGTON DS106

An open, online course on digital storytelling, ds106 moves beyond the capabilities of most MOOCs into a learning experience that happens on multiple platforms and across multiple mediums. The course is offered as part of the computer science catalog at the University of Mary Washington—but ds106 is open to anyone, anywhere, at any time.

Participants in ds106 co-learn and co-create to build their own digital story while engaging in dialogue about the ways we communicate with each other through video, audio, social media, and artwork. The course is described as "part storytelling workshop, part technology training, and most importantly, part critical interrogation of the digital landscape that is ever increasingly mediating how we communicate with one another."[13]

Across 15 weeks, ds106 participants complete a number of assignments across platforms (Twitter, YouTube, Instagram, WordPress, and so on), creating their own domain, Web presence, and digital story, as well as exploring the role of digital media in online communication. Materials and learning are tailored completely to student interest and passion. If a section of the course is uninteresting, students can drop in and drop out at any time, allowing ds106 participants to forge their own learning pathway.

To date, students have created a collection of more than 800 assignments, hosted on their own sites and also collected in a searchable assignment bank on the ds106 website. Students can browse or search the assignment bank, add their own creations, or chose to remix an existing creation through a tool called the Remix Machine.

Responsible Use Policies (RUP)

Districts with internet connectivity and device access also should have policies in place to promote responsible use and protect student privacy. A RUP is a written agreement among parents, students, and school personnel that outlines the terms of responsible use and consequences for misuse. Effective RUPs create an opportunity to teach students, while in school, to become responsible digital citizens, which will help them thrive in a connected world.

RUPs traditionally cover topics such as expectations for how students will interact with one another in digital spaces, what resources students may or may not access with district-provided

devices and over a school network, as well as standards for academic integrity when using technology for learning. These policies also can outline school and system agreements as to the use of student data and information. Typically, parents acknowledge that their child agrees to basic care and responsibility guidelines, and students sign a contract agreeing to follow rules governing use of the Internet and online conduct.

RUPs should be written in plain language that is easily accessible to students, parents, and district personnel. Technology also can assist in the easy translation of these policies into other languages, providing a bridge to communication that otherwise might leave some families disconnected. If policies and procedures for the use of devices are too strict, they often have unintended negative consequences, such as preventing access to legitimate educational resources. For additional information on questions to consider when drafting a RUP, see the the U.S. Department of Education's Policies for Users of Student Data: A Checklist or the CoSN publication Rethinking Acceptable Use Policies to Enable Learning: A Guide for School Districts.

Policies and procedures for device management, teaching responsible use, and safeguarding student privacy should be in place and understood by all members of the community prior to providing internet access or devices. *Future Ready Schools: Building Technology Infrastructure for Learning,* offers extensive guidance on how to prepare students to use the Internet, a school-provided or personal device at school, or a school-provided device at home appropriately.

In addition to internet access and device use, with the growing popularity of social media in learning, districts also should consider policies and guidelines for their safe and productive use in schools.

Furthermore, as students become more exposed to numerous cybersettings and cybertools, districts and schools should take steps to raise awareness and inform students, staff, and families about the variety of cyber-dangers that exist. And, take steps to teach students about responsible behavior and respectful treatment of others as part of a cybersafety training that also addresses cyberbullying.

Protections for Student Data and Privacy

The use of student data is crucial for personalized learning and continuous improvement (see **Section 4: Assessment**). Acting as the stewards of student data presents educators with several responsibilities. School officials, families, and software developers have to be mindful of how data privacy, confidentiality, and security practices affect students. Schools and districts have an obligation to tell students and families what kind of student data the school or third parties (e.g., online educational service providers) are collecting and how the data can be used. As they plan, schools and other educational institutions should be certain that policies are in place regarding who has access to student data and that students and families understand their rights and responsibilities concerning data collection.

These policies should include not only formal adoption processes for online educational services but also informal adoptions such as the downloading of an application to a mobile device and agreeing to clickwraps. A user encounters a clickwrap when asked to click on a button to accept the provider's terms of service before using an app or software. With clickwrap agreements, the act of accepting the terms of service enters the developer and the user (in this case, the school or district) into a contractual relationship akin to signing a contract. The U.S. Department of Education offers schools

and families examples, training, and other assistance in navigating privacy concerns through the Privacy Technical Assistance Center. This information includes Protecting Student Privacy While Using Online Educational Services: Requirements and Best Practices, Protecting Student Privacy While Using Online Educational Services: Model Terms of Service, and Checklist for Developing School District Privacy Programs.

KEY FEDERAL LAWS PROTECTING STUDENT DATA AND PRIVACY

The Family Educational Rights and Privacy Act (FERPA) (20 U.S.C. § 1232g; 34 CFR Part 99) is a Federal law that affords parents the right to inspect and review their children's education records, the right to seek to have the education records amended, and the right to have some control over the disclosure of personally identifiable information from the education records. When a student turns 18 years of age or attends a postsecondary education institution at any age, thereby becoming an "eligible student," the parent's rights under FERPA transfer to the student.

FERPA generally requires that parents or eligible students provide prior written consent before schools and school districts can disclose personally identifiable information from a student's education records, unless an exception to FERPA's general consent requirement applies. For example, when schools and school districts use online educational services, they must ensure that FERPA requirements are met. The U.S. Department of Education issued best practice guidance to address questions related to student privacy and the use of online educational technology in the classroom, available at http://ptac.ed.gov/document/protecting-student-privacy-while-using-online-educational-services.

The Protection of Pupil Rights Amendment (PPRA) (20 U.S.C. § 1232h; 34 CFR Part 98) is a Federal law that governs what information can be collected from students in certain surveys, analyses, and evaluations as part of programs administered by the U.S. Department of Education. For instance, students may not be required, as part of an applicable program and without prior written consent, to take any survey, analysis, or evaluation that reveals information concerning one or more of eight protected areas, including, but not limited to, behaviors and attitudes, and illegal, anti-social, self-incriminating, or demeaning behavior. PPRA also sets forth requirements for Local Educational Agencies to develop and adopt policies, in consultation with parents, concerning, for example, the collection, disclosure, and use of personal information from students for the purpose of marketing, parental notification, and the administration of certain physical examinations to students.

For more information about FERPA and PPRA, visit http://familypolicy.ed.gov/. General questions about FERPA or PPRA may be submitted to the Family Policy Compliance Office by using the Contact Us tab on that website or directly at http://familypolicy.ed.gov/content/questionscomments.

The Children's Online Privacy Protection Act (COPPA) (15 U.S.C. § 6501–6505) governs online collection of personal information from children under age 13. For example, before a developer can collect any information from a student under 13, verifiable parental consent is required. The FTC, which enforces COPPA, has said that school officials can act in the capacity of a parent to provide consent to sign students up for online educational programs at school for the use and benefit of the school, and for no other commercial purpose. The general guidance is that software companies are allowed to track students within their program, but COPPA prevents them from tracking those students across the internet.

The U.S. Department of Education issued best practice guidance to address questions related to student privacy and the use of online educational technology in the classroom, available at http://ptac.ed.gov/document/protecting-student-privacy-while-using-online-educational-services.

The Children's Internet Protection Act (CIPA) (47 U.S.C. § 254) imposes several requirements on schools or libraries that receive E-rate discounts for Internet access. Schools and libraries must certify that they have an Internet safety policy that includes technology protection measures. These protection measures must block or filter Internet access to pictures that are obscene, pornographic, or harmful to minors, and schools also must monitor the online activities of minors. Because most schools receive E-rate funds, they are required to educate their students about appropriate online behavior, including on social networking websites and in chat rooms, and to build cyberbullying awareness. Particularly if a digital learning resource requires networking among students, schools must comply with CIPA.

The Individuals with Disabilities Education Act (IDEA) also contains confidentiality of information provisions that protect personally identifiable information in education records collected, maintained, or used by participating agencies under Part B of IDEA. In general and consistent with FERPA, IDEA's confidentiality provisions require prior written consent for disclosures of personally identifiable information contained in education records unless a specific exception applies. Note that the IDEA Part B confidentiality of information provisions incorporate some of the FERPA requirements but also include several provisions that are specifically related to children with disabilities. For more information, see ED's additional guidance regarding IDEA and FERPA Confidentiality Provisions released in June 2014, available at: www.ed.gov/policy/gen/guid/ptac/pdf/idea-ferpa.pdf.

Device and Network Management

Many schools underestimate the importance of a plan for staffing and resources for ongoing monitoring, management, and maintenance of network infrastructure. We must ensure that student data are maintained in secure systems that meet all applicable federal and state requirements concerning the protection of personally identifiable information. Key elements of an infrastructure plan should include the following:

- Network management and monitoring
- User help desk and technical support
- Maintenance and upgrade of devices and equipment
- Insurance for devices
- Estimates of future demand and network capacity planning
- Licensing fees for digital learning content
- Firewall protection
- Content filtering
- Anti-virus and Anti-malware protection
- Security filtering
- Network redundancy
- Back-up recovery plans
- User cybersecurity education
- Use of open standards to ensure interoperability with other learning networks

Interoperability. As teachers and students go online for more of their teaching and learning needs, the number of systems they rely on increases. This makes it very difficult for teachers and students to see a comprehensive picture of their learning progress or to know where students are struggling so that teachers can give them effective support. There are

some approaches in place to address these challenges. For example, the Guide to EdTech Procurement from Digital Learning Now! recommends leveraging industry standards for single sign-on and data interoperability.

Single sign-on. Apps and tools can be built to enable single sign-on—allowing teachers and students to log in to all their applications with a single password. A teacher teaching six classes of students a day with multiple apps and tools needs a way to manage learning content, attendance, student progress, and grades. Students and teachers having to keep track of a different username and password to log in to each system wastes time and creates frustration. In addition, if all the different learning systems do not recognize who a student is, they cannot help schools create a complete picture of that student's learning. For all these reasons, solutions involving single sign-on are needed for teachers and students to access all their applications through a single log-in credential. Many districts are even moving from preferring single sign-on to requiring it.

Interoperable systems. No one app or tool can provide all the functionality that every teacher, student, or parent may need. Enabling teachers and students to use more than one app seamlessly goes beyond just having a common log-in. Basic information, such as student schedules or courses completed, may need to be shared from one system to another to provide the best learning experience. For example, if a student demonstrates the mastery of a new concept in an online learning platform, that might be reflected in an app that the teacher or families use to track student progress.

One common format for Web services in education is the Learning Tools Interoperability standard. The IMS Global Learning Consortium developed this standard, and information about the specification can be found on its website. This standard allows learning management systems to exchange data with other learning tools and applications approved for use by the school so that students can have a seamless learning experience even if they are using apps created by different developers.

Data interoperability and standards. Regardless of whether you enable data sharing through an existing or custom application program interface or through a data export option, in order to be useful, the data need to be in a common format. For example, when transferring student data between systems, should a system indicate gender as *M* or *F* or as *male* or *female*? Should the name of the field be *student name* or *first name*? These are essential items to define if we are going to allow students to move seamlessly between learning apps. Fortunately, data interoperability frameworks have been established to ensure data are presented in usable formats. In addition to the CEDS mentioned earlier, the following are examples of existing frameworks, resources, and organizational alliances that address the issue of data interoperability:

- The Schools Interoperability Framework (SIF) is an open data sharing specification that includes Extensible Markup Language XML for modeling educational data and service-oriented architecture for sharing the data between institutions.
- The Interoperability Standards for Education: Working Together to Strategically Connect the K–12 Enterprise, developed by CoSN, is a primer for education leaders to better understand issues related to building technology infrastructures that support learning.
- The Postsecondary Electronic Standards Council is a nonprofit umbrella organization that promotes the implementation and usage of data exchange standards.
- The Ed-Fi Alliance supports the creation of common data standards for communication among educational tools. Ed-Fi focuses on providing educators with dashboard starter kits showing real-time data displays.

Recommendations

- **Ensure students and educators have broadband access to the internet and adequate wireless connectivity, with a special focus on equity of access outside of school.**
  Although connectivity itself does not ensure transformational use of technology to enable learning, lack of connectivity almost certainly precludes it. Working with federal programs such as E-rate through the FCC, as well as with nonprofit partners such as CoSN, EducationSuperHighway, EveryoneOn, and others, states, districts, and postsecondary institutions should make sure technology-enabled learning is available for all students, everywhere, all the time.

- **Ensure that every student and educator has at least one internet access device and appropriate software and resources for research, communication, multimedia content creation, and collaboration for use in and out of school.**
  Only when learners have the tools necessary to complete these activities are they able to realize the potential of education technologies fully. States and districts should make sure such device purchases are funded sustainably with a plan for device refresh.

- **Support the development and use of openly licensed educational materials to promote innovative and creative opportunities for all learners and accelerate the development and adoption of new open technology–based learning tools and courses.**
  Similar to those leading state and local efforts under way in California, Illinois, and Washington state, administrators and policymakers at all levels and in formal and informal spaces should consider the diversified learning paths and potential cost savings inherent in the use of such openly licensed resources.

- **Draft sustainability plans for infrastructure concerns that include upgrades of wired and wireless access as well as device refresh plans and sustainable funding sources while ensuring the safety and protection of student data.**
  As state and local education institutions work to bridge the existing digital divide, they concurrently should be drafting plans for the upgrade of infrastructure necessary to meet the needs of increased user demand as well as speeds necessary for the use of evolving technologies. These plans should include specific systems and strategies for protecting student data, be drafted with cross-stakeholder groups, and include special consideration of funding sustainability and possible partners.

- **Create a comprehensive map and database of connectivity, device access, use of openly licensed educational resources, and their uses across the country.**
  To understand the digital divide better and progress toward bridging it, researchers, state and local officials, and district administrators should work in concert with one another to test connectivity speeds in schools and homes and to identify the kinds of devices to which educators and students have access and the ratios of devices to users within education institutions. The building of such a map and database would allow for the visualization of inequities of access and targeted interventions to alleviate them. In addition, the level of engagement with openly licensed learning materials should be made transparent as an indicator of progress toward equitable access and effective allocation of resources.

- **Include cybersafety and cybersecurity training for students, teachers and parents as part of district and school "Responsible Use Policy" training.**
  Crimes against children and youth and the tactics to ensnare them are becoming more sophisticated. Because children often use devices both in and outside of school, cybersafety and cybersecurity should be incorporated into Responsible Use policies and trainings. The Department of Education provides several resources to support states, schools and districts:

  - Readiness and Emergency Management for Schools (REMS) Technical Assistance (TA) Center
  - The National Center for Safe and Supportive Learning Environment
  - StopBullying.gov

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Conclusion

The timing has never been better for using technology to enable and improve learning at all levels, in all places, and for people of all backgrounds. From the modernization of E-rate to the proliferation and adoption of openly licensed educational resources, the key pieces necessary to realize best the transformations made possible by technology in education are in place.

Educators, policymakers, administrators, and teacher preparation and professional development programs now should embed these tools and resources into their practices. Working in collaboration with families, researchers, cultural institutions, and all other stakeholders, these groups can eliminate inefficiencies, reach beyond the walls of traditional classrooms, and form strong partnerships to support everywhere, all-the-time learning.

Although the presence of technology does not ensure equity and accessibility in learning, it has the power to lower barriers to both in ways previously impossible. No matter their perceived abilities or geographic locations, all learners can access resources, experiences, planning tools, and information that can set them on a path to acquiring expertise unimaginable a generation ago.

All of this can work to augment the knowledge, skills, and competencies of educators. Tools and data systems can be integrated seamlessly to provide information on student learning progress beyond the static and dated scores of traditional assessments. Learning dashboards and collaboration and communication tools can help connect teachers and families with instantaneous ease. This all is made more likely with the guidance of strong vision and leadership at all levels from teacher-leaders to school, district, and state administrators. For these roles, too, technology allows greater communication, resource sharing, and improved practice so that the vision is owned by all and dedicated to helping every individual in the system improve learning for students.

It is a time of great possibility and progress for the use of technology to support learning.

Challenges Remain

For all the possibilities of technology-enabled learning, it also creates challenges we will face as we embrace the change necessary to realize its potential. With the proliferation of devices and applications, we should build all educators' understanding of and ability to serve as stewards of student data so that only those with lawful access to the data can access it. We also need to find new and creative ways to solve the problem of connectivity in learners' homes so that the learning made possible in connected schools does not end when students leave for the day.

As we bridge the digital divide in schools and homes across the country, we also should build educator capacity to ask students to take part in new and transformational learning experiences with technology. This will require more than sharing tips in the faculty lounge or after-school

professional development for educators. It also will require systemic change on the part of teacher preparation providers so their faculty and programming reflect more closely the standards and settings for which they are preparing teacher candidates.

These partnerships between teacher preparation programs and school districts are emblematic of the types of partnerships we will need to build across all education groups if we hope to increase the use of technology in learning from an add-on to an integral and foundational component of our education system.

We Already Have Begun

As illustrated in the examples throughout this plan, there are schools, organizations, and partnerships across the country already engaged in the important work of shifting practices to serve students better through technology. Indeed, it never has been easier to share innovations and lessons learned and muster the resources necessary to catalyze learning with technology. From the NETP to Connected Educator Month to LearningRegistry.org, from rapid cycle technology evaluations to education innovation clusters: The work of educators and other stakeholders with vision and a commitment to improving learning in America is well under way.

Recommendations

Section 1: Learning

- **States, districts, and postsecondary institutions should develop and implement learning resources that embody the flexibility and power of technology to create equitable and accessible learning ecosystems that make learning possible everywhere and all the time for all students.**
  Whether creating learning resources internally, drawing on collaborative networks, or using traditional procurement procedures, institutions should insist on the use of resources and the design of learning experiences that use UD practices to ensure accessibility and increased equity of learning opportunities.

- **States, districts, and postsecondary institutions should develop and implement learning resources that use technology to embody design principles from the learning sciences.**
  Educational systems have access to cutting-edge learning sciences research. To make better use of the existing body of research literature, however, educators and researchers will need to work together to determine the most useful dissemination methods for easy incorporation and synthesis of research findings into teachers' instructional practices.

- **States, districts, and postsecondary institutions should take inventory of and align all learning technology resources to intended educational outcomes. Using this inventory, they should document all possible learner pathways to expertise, such as combinations of formal and informal learning, blended learning, and distance learning.**
  Without thoughtful accounting of the available tools and resources within formal and informal learning spaces within a community, matching learners to high-quality pathways to expertise is left to chance. Such an undertaking will require increased capacity within organizations that have never considered such a mapping of educational pathways. To aid in these efforts, networks such as LRNG, the Hive Learning Networks, and education innovation clusters can serve as models for cross-stakeholder collaboration in the interest of best practices for using existing resources to present learners with pathways to learning and expertise.

- **Education stakeholders should develop a born accessible standard of learning resource design to help educators select and evaluate learning resources for accessibility and equity of learning experience.**
  Born accessible is a play on the term born digital and is used to convey the idea that materials that are born digital also can and should be born accessible. If producers adopt current industry standards for producing educational materials, materials will be accessible out of the box. Using the principles and research-base of UD and UDL, this standard would serve as a commonly accepted framework and language around design for accessibility and offer guidance to vendors and third-party technology developers in interactions with states, districts, and institutions of higher education.

- **More research is needed on how the learning sciences—the scientific study of how people learn—can inform how technology is developed and used in school settings.**
  Researchers in this field address research questions such as how to optimally present information to students, what study strategies lead to optimal retention of information, and what and how content should be taught. Foundational knowledge about how people learn can be used to design more effective education technology products that align to how the mind works. Hirsh-Pasek, et al., for example, propose a learning sciences framework for identifying potentially effective educational apps based on four factors: active, engaged, meaningful, and socially interactive learning. Similar frameworks could be developed to guide the development and identification of other types of effective education technology products.[1]

Section 2: Teaching

- **Provide pre-service and in-service educators with professional learning experiences powered by technology to increase their digital literacy and enable them to create compelling learning activities that improve learning and teaching, assessment, and instructional practices.**
  To make this goal a reality, teacher preparation programs, school systems, state and local policymakers, and educators should come together in the interest of designing pre- and in-service professional learning opportunities that are aligned specifically with technology expectations outlined within state standards and that are reflective of the increased connectivity of and access to devices in schools. Technology should not be separate from content area learning but used to transform and expand pre- and in-service learning as an integral part of teacher learning.

- **Use technology to provide all learners with online access to effective teaching and better learning opportunities with options in places where they are not otherwise available.**
  This goal will require leveraging partner organizations and building institutional and teacher capacity to take advantage of free and openly licensed educational content such as those indexed through Learning Registry's #GoOpen Node (LearningRegistry.org). Adequate connectivity will increase equitable access to resources, instruction, expertise, and learning pathways regardless of learners' geography, socio-economic status, or other factors that historically may have put them at an educational disadvantage.

- **Develop a teaching force skilled in online and blended instruction.**
  Our education system continues to see a marked increase in online learning opportunities and blended learning models in traditional schools. To meet the need this represents better, institutions of higher education, school districts, classroom educators, and researchers need to come together to ensure practitioners have access to current information regarding research-supported practices and an understanding of the best use of emerging online technologies to support learning in online and blended spaces.

- **Develop a common set of technology competency expectations for university professors and candidates exiting teacher preparation programs for teaching in technologically enabled schools and postsecondary education institutions.**
  There should be no uncertainty of whether a learner entering a PK–12 classroom or college lecture hall will encounter a teacher or instructor fully capable of taking advantage of technology to transform learning. Accrediting institutions, advocacy organizations, state policymakers, administrators, and educators have to collaborate on a set of clear and common expectations and credentialing regarding educators' abilities to design and implement technology-enabled learning environments effectively.

Section 3: Leadership

- **Establish clear strategic planning connections among all state, district, university, and school levels and how they relate to and are supported by technology to improve learning.**
  State and local authorities are uniquely suited to understand the needs and resources available within their local education ecosystems. Broad, coordinated strategic planning requires a commitment from all parties involved to collaborate consistently across organizational boundaries. These conversations and connections need proactive champions who will invest in working at this level and who can take advantage of existing state and regional conferences to further this work.

- **Set a vision for the use of technology to enable learning such that leaders bring all stakeholder groups to the table, including students, educators, families, technology professionals, community groups, cultural institutions, and other interested parties.**
  Although not all parties will be responsible for the execution of a vision for the use of technology to enable learning, by making certain all involved stakeholder groups are part of the vision-setting process, leaders will ensure better community support and the establishment of a plan for learning technology that reflects local needs and goals.

- **Develop funding models and plans for sustainable technology purchases and leverage openly licensed content while paying special attention to eliminating those resources and tasks that can be made obsolete by technology.**
  Rather than viewing technology as an add-on component to support learning, leaders should take stock of current systems and processes across learning systems and identify those that can be augmented or replaced by existing technologies. During the planning process, they also should identify systems and processes for which no replacement currently exists within the district, school, or college and set goals for developing more efficient solutions.

- **Develop clear communities of practice for education leaders at all levels that act as a hub for setting vision, understanding research, and sharing practices.**
  Building on the model of the education innovation clusters, state, district, university, and community organization leaders should establish cohesive communities of practice—in person and online—to create virtuous cycles for sharing the most recent research and effective practices in the use of educational technology.

Section 4: Assessment

- **Revise practices, policies, and regulations to ensure privacy and information protection while enabling a model of assessment that includes ongoing gathering and sharing of data for continuous improvement of learning and teaching.**
  This will require not only greater systems interoperability standards but also increased capacity on the part of educators and administrators to understand the types of systems they want to establish within schools and colleges. In addition, they will need to have an understanding of the standards of interoperability they should demand from vendors. A key component of this increased capacity should ensure educational leaders have a firm understanding of privacy and security concerns, how those concerns are addressed within the school or system, and clear communication of policies and procedures with all stakeholders. Achievement of this recommendation would benefit from the involvement and guidance of organizations, such as CoSN, ISTE, and the State Educational Technology Directors Association (SETDA), that have developed specialized expertise in these areas.

- **States, districts, and others should design, develop, and implement learning dashboards, response systems, and communication pathways that give students, educators, families, and other stakeholders timely and actionable feedback about student learning to improve achievement and instructional practices.**
  The next generation of such tools should integrate across platforms and tools seamlessly, be designed with a mobile-first mindset, and be guided by UD and UDL principles to ensure accessibility by all stakeholders. Although current products and dashboards include basic functionality and features that improve on those of their predecessors, future iterations should be built on a premise of feedback and conversation, allowing learners and families to discuss learning outcomes and evidence and increasing agency and ownership across stakeholder groups.

- **Create and validate an integrated system for designing and implementing valid, reliable, and cost-effective assessments of complex aspects of 21st-century expertise and competencies across academic disciplines.**
  Interoperable formative assessment formats offered by major testing consortia for use by educators throughout the year are an important first step. However, work remains to ensure more educators have access to high-quality formative assessment tools and to develop additional capacities to assess both cognitive and non-cognitive skills better. Moving forward, increasing educator capacity for the design and deployment of valid and reliable formative assessments will require the concerted efforts of current sessment developers, teacher preparation programs, school systems, and researchers. Furthermore, colleges and universities will benefit from system-wide reviews of assessment practices and from ensuring all faculty have deep understandings of key principles and practices surrounding the design and implementation of effective learning assessments.

- **Research and development should be conducted that explores how embedded assessment technologies such as simulations, collaboration environments, virtual worlds, games, and cognitive tutors can be used to engage and motivate learners while assessing complex skills.**
  Although some of this research is in its early stages, the way forward will require close collaboration among organizations—such as GlassLab, Games for Change, and iCivics; colleges, universities, informal learning spaces, and schools; philanthropic organizations; and research institutions—that have a deep understanding of how game mechanics increase learner motivation. This collaboration can increase the likelihood of effective and engaging experiences being built to support learning.

Section 5: Infrastructure

- **Ensure students and educators have broadband access to the internet and adequate wireless connectivity, with a special focus on equity of access outside of school.**
  Although connectivity itself does not ensure transformational use of technology to enable learning, lack of connectivity almost certainly precludes it. Working with federal programs such as E-rate through the FCC, as well as with nonprofit partners such as CoSN, EducationSuperHighway, EveryoneOn, and others, states, districts, and postsecondary institutions should make sure technology-enabled learning is available for all students, everywhere, all the time.

- **Ensure that every student and educator has at least one internet access device and appropriate software and resources for research, communication, multimedia content creation, and collaboration for use in and out of school.**
  Only when learners have the tools necessary to complete these activities are they able to realize the potential of education technologies fully. States and districts should make sure such device purchases are funded sustainably with a plan for device refresh.

- **Support the development and use of openly licensed educational materials to promote innovative and creative opportunities for all learners and accelerate the development and adoption of new open technology–based learning tools and courses.**
  Similar to those leading state and local efforts under way in California, Illinois, and Washington state, administrators and policymakers at all levels and in formal and informal spaces should consider the diversified learning paths and potential cost savings inherent in the use of such openly licensed resources.

- **Draft sustainability plans for infrastructure concerns that include upgrades of wired and wireless access as well as device refresh plans and sustainable funding sources while ensuring the safety and protection of student data.**
  As state and local education institutions work to bridge the existing digital divide, they concurrently should be drafting plans for the upgrade of infrastructure necessary to meet the needs of increased user demand as well as speeds necessary for the use of evolving technologies. These plans should include specific systems and strategies for protecting student data, be drafted with cross-stakeholder groups, and include special consideration of funding sustainability and possible partners.

- **Create a comprehensive map and database of connectivity, device access, use of openly licensed educational resources, and their uses across the country.**
  To understand the digital divide better and progress toward bridging it, researchers, state and local officials, and district administrators should work in concert with one another to test connectivity speeds in schools and homes and to identify the kinds of devices to which educators and students have access and the ratios of devices to users within education institutions. The building of such a map and database would allow for the visualization of inequities of access and targeted interventions to alleviate them. In addition, the level of engagement with openly licensed learning materials should be made transparent as an indicator of progress toward equitable access and effective allocation of resources.

- **Include cybersafety and cybersecurity training for students, teachers and parents as part of district and school "Responsible Use Policy" training.**
  Crimes against children and youth and the tactics to ensnare them are becoming more sophisticated. Because children often use devices both in and outside of school, cybersafety and cybersecurity should be incorporated into Responsible Use policies and trainings. The Department of Education provides several resources to support states, schools and districts:

  - Readiness and Emergency Management for Schools (REMS) Technical Assistance (TA) Center
  - The National Center for Safe and Supportive Learning Environment
  - StopBullying.gov

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Appendix A

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Appendix B

Acknowledgments

Project Team

The 2017 NETP Update was developed under the guidance of **Joseph South** and **Katrina Stevens** of the U.S. Department of Education, OET. Within the OET, technical assistance was provided by **Christine Stokes-Beverley, Susan Bearden, Kristina Peters, Jacqueline Pugh, Sara Trettin,** and **Angela Vann**.

Casandra Woodall served as the principal lead in updating the 2017 NETP. **Susan Thomas** served as the principal writer for the NETP 2016.

Additional 2017 NETP Update contributions were provided by **Bill Bass, Carolyn Foote, Frances Frost, Dina Lehmann-Kim, Kim Lindskog,** and **Kristen Mattson**

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Interviews

Public Policymakers

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Margaret Honey President and CEO, New York Hall of Science

Barbara Means Director, Technology in Learning, SRI International

Tracy Weeks Executive Director, State Educational Technology Directors Association

Outreach Events

SETDA October 29, 2014

iNACOL Conference November 4, 2014

Higher Education Experts November 9, 2014

ConnectED to the Future Superintendent Summit November 18, 2014

Open Education Experts November 20, 2014

ISTE Conference December 5, 2014

Silicon Valley—Innovators February 24, 2015

Silicon Valley—Developers and Investors February 24, 2015

PDX—Portland State University Conference February 25, 2015

SETDA and CoSN Washington Education Technology Policy Summit April 6-7, 2016

SETDA Emerging Technologies Leadership Forum June 24-27, 2016

SETDA Leadership Summit October 16-19, 2016

Target Virtual Outreach

Classroom Teachers February 9, 2015

Assessment Experts February 11, 2015

Adult Education Experts February 18, 2015

Librarians February 18, 2015

Teacher Preparation Experts February 18, 2015

District Administrators February 19, 2015

Informal Learning Experts February 20, 2015

Researchers February 20, 2015

External Reviewers

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Appendix C

The Development of the 2016 NETP

The 2016 NETP builds on the foundation of the 2010 Plan, *Transforming American Education: Learning Powered by Technology.* The 2016 NETP explores the exciting advances, opportunities, and research that illustrate how teaching and learning can be enhanced with the innovative use of technology and openly licensed content and resources. The 2016 NETP offers a vision of how technology can transform formal and informal learning, the critical elements such as qualified teachers and staff, high-quality curriculum and resources, strong leadership, robust infrastructure, and aligned assessments.

The development of the 2016 NETP began with a series of meetings with the TWG, which consisted of 13 leading educators, technology innovators, and researchers. The first meeting was a one-day gathering to develop the vision and overarching themes. On the basis of expertise and interest, each of the TWG members was assigned to a sub-group to focus on one of the five key topic areas: Learning, Teaching, Leadership, Assessment, and Infrastructure. TWG members provided feedback that informed the development of the 2016 NETP outline and working drafts, including the identification of relevant research and exemplary programs. The TWG reviewed two drafts and offered their comments and recommendations, which were incorporated into the final document. In addition, a group of national content experts and members of key stakeholder groups reviewed and provided feedback on an early draft, which was also incorporated into the document.

The 2016 NETP also was informed by a series of interviews conducted by the AIR team with 31 leaders from the U.S. Department of Education; the White House Office of Science and Technology Policy; and other government agencies, technology innovators, and nonprofit organizations. These interviews provided valuable insight into the priorities and practices being implemented to further the goals of ensuring equity and accessibility to high-quality instruction enabled by technology for all students.

In addition, the AIR team convened a series of nine face-to-face and eight virtual focus groups to gather further insights and recommendations for the 2016 NETP. The participants represented a broad cross section of key stakeholders, including practitioners, state and local administrators, technology innovators, experts, and developers. The focus groups also provided the opportunity for participants to identify exemplars of the innovative use of technology in formal and informal educational settings.

Throughout the development process for the 2016 NETP, attention was focused on the compilation and review of proposed examples to illustrate the innovative use of technology across the five areas of Learning, Teaching, Leadership, Assessment, and Infrastructure. Suggestions were collected from the TWG members, interviewees, focus group participants, and AIR and OET staff. In addition, the AIR team conducted a review of the literature, a survey of national education technology initiatives (for example, Future Ready, CoSN, ISTE, and Digital Promise), and Internet searches to identify these exemplary programs and initiatives. More than 235

examples were identified during the course of the project. In an effort to identify those examples that best aligned with the 2016 NETP, the AIR and OET teams used the following screening criteria to make the final selection: quality of the user experience, evidence of success, and clear use of technology (where appropriate). A total of 53 examples are included in the 2016 NETP to deepen an understanding of the innovative use of technology to enhance teaching and learning in formal and informal settings.

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