



Connected Teaching and Personalized Learning: Implications of the National Education Technology Plan (NETP) for Adult Education

Final Report

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I. INTRODUCTION

The National Education Technology Plan (NETP) lays out a broad vision of how technology can improve teaching and learning. Through the smarter use of data, programs and teachers can direct their own learning, participate in online and hybrid communities of practice in their areas of interest, and seek assistance from peers or mentors far removed from the classroom. This vision of “connected teaching” and “personalized learning” can be applied to the adult education field and adult learners who are not currently connected to an established program. The plan also includes some “grand challenges” meant to spur the national imagination.

The promise of technology to improve the effectiveness of the educational system at all levels is in various stages of realization; great strides are being made in some sectors and some platforms offer new opportunities for disseminating knowledge and more opportunities for peer-to-peer learning. The NETP expresses a vision for the role of technology in education to improve teaching and learning, increase access to high-quality educational services, and improve the productivity and efficiency of educational systems. It offers a framework for comprehensive education reform that holds both potential and challenges for its implementation in the adult education system.

This report discusses the realizable implications of the NETP specifically for adult education and prioritizes the implementation of policy and practice recommendations for maximizing the potential of technology in adult education, given existing resources. The overall goal of this report is to suggest a framework in adult education to implement the mandates implicit in the NETP by answering the following key questions about the practical implications of the broad vision of the NETP for adult education:

- How can the adult education field realize the vision and goals of the NETP, given limited resources?
- Which NETP areas should be the field’s immediate focus, and what are the implications for policy and practice?
- How can the vision of connected teaching and personalized learning be applied to the adult education field and for adult learners currently unconnected to an established program?

The Vision, Goal, and Purpose of the NETP

The first NETP, released in 1996, was developed under Congressional mandate in the mid-1990s. The Improving America’s Schools Act of 1994 (IASA) appropriated funding for state and local education agencies to acquire and use educational technology to provide educational services. It also required the Secretary of Education to report on the opportunities and challenges of educational technology and to specify practice, policy, and research recommendations for overcoming barriers to fully exploiting existing educational technology. In 2000, the plan was reviewed and revised with a focus on e-learning and increased access to education (U.S. Department of Education, 2000). With the No Child Left Behind Act of 2001 (NCLB), Congress required another national technology plan, which was released in 2005. This plan, like NCLB,

focused on student achievement and accountability. Historically, this report has taken the form of a comprehensive 5-year plan, the NETP, which lays out the nation’s vision for using technology in education across schools. The NETP has influenced—and continues to influence—action at the state and local levels surrounding the use of technology in education in that it sets the standard for integrating technology into education for educational institutions across the country.

As in prior reports, the NETP reflects the status of educational technology and prevailing theories about student learning, educator professional development, and the role of institutional stakeholders. The current NETP, which builds on earlier reports, shows a more evolved understanding of how technology can be used to support student learning and growth. It also presents a vision of technology use—shaped by leaders in education, industry, and research; the public, and learners—that transforms education and moves the country toward meeting the Obama administration’s goals of closing the achievement gap and leading the world in college completion (U.S. Department of Education, 2010). The NETP establishes long-range goals and recommendations for action at the state, local, and federal levels and proposes actions that other stakeholders can take in five key areas:

- 1. Learning**—“All learners will have engaging and empowering learning experiences both in and out of school that prepare them to be active, creative, knowledgeable, and ethical participants in our globally networked society” (U.S. Department of Education, p. 9).
- 2. Assessment**—“Our education system at all levels will leverage the power of technology to measure what matters and use assessment data for continuous improvement” (p. 25).
- 3. Teaching**—“Professional educators will be supported individually and in teams by technology that connects them to data, content, resources, expertise, and learning experiences that can empower and inspire them to provide more effective teaching for all learners” (p. 39).
- 4. Infrastructure**—“All students and educators will have access to a comprehensive infrastructure for learning when and where they need it” (p. 51).
- 5. Productivity**—“Our education system at all levels will redesign processes and structures to take advantage of the power of technology to improve learning outcomes while making more efficient use of time, money, and staff” (p. 63).

Collectively the goals and recommendations in the five key areas form a blueprint for education reform enabled by technology. Additionally, the plan showcases examples of innovative uses of technology for student learning and instruction and presents a research agenda to address with technology challenges to learning and assessment.

The NETP and Adult Education

Adult education providers throughout the country serve adult learners by offering basic instruction and educational services to adults below the postsecondary level in reading and mathematics and English language instruction for non-native speakers of English. In the context of the Workforce Investment Act of 1998, “adult learners” are adults aged 16 years and older who are not enrolled or required to be enrolled in schools and who lack high school equivalency or basic skills. According to a report based on 2000 Census data, 40 million people across the United States are estimated to need adult basic education, general educational development (GED), English as a second language (ESL), and/or vocational literacy skills (Lasater & Elliott, 2005). The National Assessment of Adult Literacy estimated the number of adults at the below-basic level to be 41 million; of those, 11 million were nonliterate in English (Baer, Kutner, & Sabatini, 2009). Adult education programs serve approximately 2 million of these people through state and community-based programs (U.S. Department of Education, 2009). These programs are necessary for developing the skills that adults need to obtain high school equivalency, enter the workforce, transition to postsecondary studies, and increase civic and parental engagement.

Educators and administrators who provide these services to adult learners form a very diverse workforce owing to the great variety of requirements for professional certification, training, and compensation (Bureau of Labor Statistics, 2013). Currently, the demand for adult basic education and related services is greater than existing resources can accommodate, and there is an urgent need to serve all those in need of services so that more adults can compete in the labor market (Forster, Strawn, & Benfield, 2011; National Council of State Directors of Education, 2010). The recommendations presented in the NETP provide insight into how technology can be used to expand services to adult learners, given existing and attainable resources—not by compromising but by improving learner outcomes. The pertinence of the plan to adult education is made clear by shows of support from the adult education field, specifically the National Coalition for Literacy, which issued a response to the NETP from an adult education perspective and subsequently adopted the plan as policy (National Coalition for Literacy, 2010).

There is great and achievable potential for technology to be leveraged in adult education to improve and expand the instructional services now offered to students. Advances in and implementation of technology have major implications not only for instruction and learning in adult education but also for the accountability of adult education providers. Potential uses of technology in adult education include adding relevant context to instruction; making it more meaningful and engaging to learners; giving students the power to identify skill deficits and develop a plan of study based on that information; providing targeted professional development; helping educators and program administrators make data-driven instructional and learning decisions; and tying outcomes such as job placement and high school completion to early academic indicators and other measures of student growth and learning.

The many challenges that hamper K–12 education and warrant a technology-fueled transformation in primary education, as called for in the NETP, also exist in adult education. However, the unique context of the adult education field and adult learners themselves require a different lens for understanding and responding to the mandates of the NETP. Adult learners as a group are poised to very quickly—if not immediately—help meet the targets for the President’s goals to increase the number of high school and college graduates and close the achievement gap

because many have personal goals tied to high school completion and college and career readiness (U.S. Department of Education, 2010). The importance of adult learners in meeting the goals of the Obama administration cannot be overstated, and thus the implications of the NETP for adult education are also quite significant and require careful consideration followed by strategic action.

About This Report

The vision and goals of the 2010 NETP for adult education builds on the momentum for innovation and the steadily growing use of educational technology. This report looks at what can and should be done given existing environmental conditions, and what needs to be done now to prepare for meeting longer-term goals. Although this report follows the structure of the NETP by addressing its five areas of concern—Learning, Assessment, Teaching, Infrastructure, and Productivity—these areas must be seen as integrated and interdependent if they are to enhance opportunities in the adult education system.

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II. LEARNING

The themes of engaging and empowering learners set out in the NETP have great resonance for the ongoing development of adult education in the United States. Even though adult learners may have strong motivation for entering a formal adult education program—preparing for a GED exam, developing language skills for a citizenship test or employment, aspiring to attend community college—it is more likely that they will persist in their learning and achieve their goals if they are engaged in the learning process. The personal attention of a teacher remains important in our technologically oriented world, but new types of learning materials, new instruction methods, new facilitation methods, and new modes of communication can enhance engagement with content, provide students with new skills, and help reach a wide range of students with varying needs.

Many reports and studies advise that adult students learn best when content is linked to their particular interests, future careers, and backgrounds. As adult education is transformed, opportunities exist to develop new types of learning materials that couple basic literacy and numeracy skills with subject and career content. Students may find that language or mathematics content that uses examples from a field in which they currently work or aspire to work is more engaging than generic content.

If students can learn new technologies in a way that is integrated with the content they need to master, they will derive several benefits. In particular, technology skills have the potential to make individuals more desirable employees. Enhanced technology skills can enable students who are parents and adjusting to the norms of U.S. society both to seek helpful information on the Internet and supervise their children’s responsible use of the Internet. According to the Institute of Museum and Library Services, digital literacy means being able to find, evaluate, and use information to achieve one’s goals. By extension, a digitally literate adult learner would be able to create, post, and link content and contribute to community discussions. Importantly, digital literacy helps adult learners to achieve the Administration’s goals—to close the achievement gap and increase college attendance and completion. Learning also takes place outside the classroom, and digitally literate adults are empowered to seek out information and learning opportunities for themselves.

Many institutions of higher education are moving to pedagogies that combine in-person and online aspects, often referred to as *blended learning*. This learning modality may have advantages for adult learners by giving them more flexibility in their schedules, such as combining less scheduled, face-time instruction with additional work online. But for some adult students, the online component may present onerous challenges. Some individuals will have difficulty finding time to focus on learning beyond scheduled classroom time; some will not have access to appropriate learning environments—including Internet access—outside the classroom.

Short-Term Strategies and Recommendations

Fully online courses or workshops for basic literacy and numeracy skills are feasible, but they may not be desirable for most students. A study by researchers at the Community College Research Center at Columbia University (Xu & Jaggars, 2013) found that almost all groups of

students did not do as well (in completion or grades earned) in fully online classes as in-person courses (blended learning was not included). Older students were less likely to complete online courses than in-person courses, but those who completed them achieved higher grades. This result may indicate that some subgroups of adult learners, for example, workers who have an immediate employment-related need to take the courses, find that the online environment suits their needs well.

A wide variety of teaching and learning methods can be employed to engage students in their learning and support the development of 21st-century skills. Many educators believe that the methods described below are preferable to the traditional lecture mode, which does little to engage students. These modes and techniques can be used in the classroom or as homework activities. Some are exclusive to an online environment, and others may be used in blended or in-person contexts. Examples include:

- Active learning
- Problem-based learning
- Games and simulations
- Massive open online courses (MOOCs)
- Mobile technologies

Following is an exploration of each of these methods and technology-based possibilities for the adult learner.

Active Learning and Problem-Based Learning

The NETP calls for the empowerment of learners. One way to accomplish this is to develop curricula or modules of curricula that incorporate assignments and learning activities for which students are content creators, creating digital content and contributing it to the Internet environment, and providing detailed information on the resources required. Students might be given assignments to use technologies to produce materials that are important to their work and family lives—posting videos and photos, creating blogs, contributing to wikis, or participating in a Facebook group. They might also participate in the authentic work of science by joining in citizen science activities. Contributing to such online projects and learning about science principles could engage and motivate students in their learning. These kinds of activities give students some control over their learning and can incorporate subject-based learning with the development of technology skills.

If these activities are done in class, they require a technology-equipped classroom and a teacher or other staff with the requisite skills to work with students. Students can produce videos illustrating basic mathematics concepts that they use in their daily lives. They can build a class website that includes information about the community in which they live. As they gain skills, they can produce podcasts that describe their own successful learning strategies for future students. These kinds of projects will develop students' skills with the subject matter (mathematics, language), give them practice with technologies that enhance their résumés and their capability for entering community college programs, and engage them in their work.

Students are empowered in their learning when they can choose learning materials that have a particular resonance for their stage of development, their preferred modality, and a subject that either interests them or is important for their work or family life. Providing students with information on access to high-quality online educational resources that they can use both in and outside of class will potentially encourage them to spend more time on learning because they will be engaged with the material.

Instructors can be encouraged to guide their students as they look for learning materials at the level appropriate for their needs. Any of the preceding methodologies can draw on open educational resources in large collections such as the National Science Digital Library (NSDL; <http://www.nsdli.org>) and the Multimedia Educational Resource for Learning and Online Teaching (MERLOT; <http://www.merlot.org/merlot/index.htm>) and can also benefit from the videos available through the Khan Academy (<https://www.khanacademy.org/>) and similar resources. (The Khan Academy includes a section on arithmetic and pre-algebra with video lectures and practice problems.)

Open educational resources (OERs) offer a wide variety of tools that learners can use. The NETP defines OERs as “teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits sharing, accessing, repurposing—including for commercial purposes—and collaborating with others” (U.S. Department of Education, 2010, p. 55). Developed by many parties across the country, OERs can be used with learners at various levels of competency and with various disciplinary or subject interests. The NSDL contains many science, technology, engineering, and mathematics (STEM) learning resources; however, there is no clear metadata for materials particularly suited to adult education settings. MERLOT is another example of a repository of learning objects, many of which are produced primarily for higher education but that may be adapted for use with adult learners. Another resource is OER Commons (<http://oercommons.org>), which contains many resources suitable for adult learners. Increasingly, effective tagging practices are making it easier for adult learners to locate materials that are at an appropriate instructional level. When any of the preceding repositories are combined with distribution through mainstream channels such as YouTube, adult learners are more likely to become aware of these digital resources as helpful learning materials. (Note: More information on OERs may be found in the Teaching section.)

Targeted research can be conducted on how students find open education resources and how these resources can be marketed to adult education students. The results of this research can prompt better tagging of resources so that they are easily accessed through popular search engines, and the results can be used to develop outreach mechanisms to “push” content to students. Will ads in public transportation venues (stations, buses) catch students’ attention and prompt them to check some of these resources for adult education? Will public service announcements on popular television programs or radio stations drive traffic to some sites with good materials for adult education students? Much good content remains largely invisible to students. Social networking can also be used to get the word out; Twitter might be useful, but there is a question regarding how to encourage students to subscribe to that stream. Enlisting a popular personality is one way to market resources on Twitter.

Games and Simulations

Game developers can be encouraged to invest in producing games for high-value areas, such as technology skills, civics, English language, basic mathematics, and the health sciences—perhaps within the framework of the Common Core State Standards. Such games, which can be used by hundreds of thousands of users, should track levels of accomplishment for individuals, provide feedback on progress, and be portable for use on mobile devices.

It is important that games for educational purposes have strong production values to engage an audience that plays highly visual and interactive online games for leisure; this can require a substantial investment of time and funds.

Students may be motivated by competing against their fellow students or may find that incentives such as a badge (including virtual rewards) increase the time they spend on mundane tasks, such as learning math facts. Games can be used in class, and students can also be encouraged to continue to play for practice outside of class time.

MOOCs

Supporting a MOOC-style course on basic skills (e.g., mathematics, literacy) will help potential developers better understand whether this is a fruitful area for investment. Developing a MOOC entails preparing short video lectures on a particular subject. For a national audience of potentially hundreds of thousands of users, it might be possible to recruit a cast of notables to deliver basic literacy or numeracy instruction. In this scenario, curricular experts prepare the scripts and materials, and well-known individuals from a variety of sectors (e.g., government, sports, entertainment, the arts) deliver them. Because MOOCs do not have to follow a standard semester schedule, they can be a variety of lengths and reoffered many times. MOOC sessions tend to be much shorter than the typical 1-hour college lecture.

In the adult education arena, it is possible to have a teacher known to have excellent lecture skills deliver short videos in STEM, English language, or civics curricula (or the video presenters could be notable individuals in a variety of fields, each of whom gives a brief lecture). These videos can be assigned as homework for students and the students can attend in-person classes as a supplement. Many MOOCs look for ways to incorporate social interaction. In the adult education context, synchronous teacher-facilitated group sessions supplement the video lectures via in-person group sessions (for practice, problem solving, and homework) or online.

The adult education audience has two options: a totally online option that requires students to participate in online groups that include peers and a mentor; and a blended option that also has students attend in-person sessions where they meet with peers and a teacher to complete homework, practice exercises, and take exams. If students have problems with particular concepts, the learning management system (i.e., the online platform in which instruction is delivered online, whether in an entirely online class or through blended instruction) can direct them to supplemental materials. The system also collects data that the teacher can use to determine what is and is not working in the instruction.

As part of a MOOC, students do homework and take exams. If analytics are built into the system, data on the effectiveness can be collected and improvements introduced in later versions of

course materials. Comparisons can be made between student success in the online-only versus the blended version of the MOOC.

At present, the percentage of students who complete a MOOC-delivered course is very low; however, not all students take these courses with the intention of completing them. For example, when a scientist delivers a MOOC, some of his or her peers listen to the course content and have little reason to complete exercises or a final exam. We do not yet fully understand the benefits and challenges of MOOCs.

Mobile Technologies

Most adults already carry one or more portable devices, such as feature phones, smartphones, MP3 players, and tablets, all of which can access content. Although many adult learners may not have smart phones, most have feature phones. Programming is available to make a feature phone similar to a smart phone so that one does not necessarily need an extensive data plan. Agencies that monitor and promote adult education can use statistics produced by the Pew Internet & American Life Project (<http://www.pewinternet.org/>) or other resources to track the student population's adoption of mobile devices. Agencies also need to understand which community resources (schools, libraries, clubs, or other nonprofits) provide access to mobile devices and Internet connectivity outside of class and ensure that students are aware of them.

Mobile technologies have a great deal of utility in adult education and are another way to empower students in their learning, giving them more options and greater control over where and how they learn. If students can access interactive practice exercises on a mobile device, they can more effectively use short periods of time while commuting, during meal breaks at work, and so on. Students need a great deal of repetitive practice in some basic subject areas such as English language literacy (National Research Council, 2012), and mobile devices loaded with audio, video, or game content are ideal for this purpose. Mobile phones are especially useful for language learning (Simon & Fell, 2012).

Promoting activities that encourage adult education students to develop applications or learning activities for mobile devices has the potential to engage and empower them. For example, the MIT Media Lab recently sponsored a contest encouraging middle and high school students to submit ideas for mobile learning applications (apps). The winning teams then had the opportunity to work with the Lab to refine and implement their ideas. One winning idea was a mythology-themed game to help students increase their speed in basic mathematical computation. Another was a note-taking aid for students with disabilities (see <http://appchallenge.tsaweb.org/>).

In a similar vein, adult education programs can sponsor contests for students to develop apps that can be used in these programs. A contest encourages students to develop their technology skills; as they develop content for the app, they improve their own understanding of the subject of the app. Contests can be motivating for students, and the award could be no-cost or low-cost; however, the ability to include an award for creating an app on a résumé or a job or college application might be considered reward enough. Students can work on app development as a class assignment; support will most likely be needed and can be provided by high school students or college service learning participants interested in a community service project.

Long-Term Strategies and Recommendations

The NETP highlights an innovative pilot program in the New York City school system called *School of One*. This program personalizes education programs for students learning basic mathematics skills, using assessments to determine each student's level and inputs to help determine the student's preferred learning modes. Although the program has some online components, it emphasizes in-person activities and support. The guiding principles of this kind of program, as described in the NETP, are individualization, differentiation, and personalization. These principles are especially relevant for students in adult education programs, who have a particularly wide range of backgrounds and may have a wide variety of learning preferences. In this kind of program, students are likely to be more engaged in their learning because they can move at their own pace and not be distracted by their classmates' pace. They can find, or be delivered, the kinds of learning materials they prefer, such as videos, games, and interactive materials. They can obtain quick feedback through mechanisms, often referred to as *learning analytics*, built into the learning systems to gauge their progress.

Courses with strong, interactive technology components that include frequent feedback and use learning analytics help students gauge progress and locate additional resources when they have difficulty with particular parts of the work. These courses require a major investment of time, expertise, and funds to produce high-quality, tested materials in a variety of subject areas for various levels. Online components have built-in learning analytics, which offer students feedback on their progress and alternate paths, depending on their strengths, weaknesses, gaps in previous education, and learning modality preferences.

The need for research on technology's impact on learning is ongoing. It may take time to develop specific evidence for what is working in adult basic education. Research that determines effective practices for using technology in adult education contexts should be supported. Specific areas to be addressed include determining which types of students achieve the most in various environments (e.g., fully face-to-face, blended, and fully online) and what kinds of learning environments help students achieve in specific subject areas and levels.

As more programs integrate the extensive use of online educational content—especially if that content is linked to educational standards—opportunities will arise to develop individualized learning records that students can access no matter which educational institution or program they are affiliated with. Adult students may move around because of job or family changes or they may drop out of the education environment for a few years. If they can easily access a record of their past accomplishments, these adult students can ease back into an educational program at an appropriate level.

E-portfolios are currently one mechanism for creating and using digital records of learning. E-portfolios differ from institutionally managed records because they are compiled and owned by the learners themselves. Adult learners can record their learning experiences and collect evidence of the competencies they have developed in e-portfolios, which make them available to audiences such as educational institutions, counselors, and potential employers (Cambridge, 2010). In the United States, eFolio Minnesota is the largest initiative that engages adult learners in compiling and using e-portfolios. Supported by the Minnesota State Colleges and Universities system, eFolio Minnesota makes online e-portfolio software available to all state residents.

Through workforce development agencies, schools, and institutions of higher education, learners are supported in preparing their e-portfolios and using them to set goals, choose learning opportunities, seek employment, and communicate their experiences and commitments to both personal and professional audiences (Cambridge, 2008). In the process of developing their e-portfolios, learners also develop their technology and communications skills.

Implications for Policy and Practice

Although more and more Americans have mobile devices, educators cannot assume that every student will have his or her own device that can be used for learning. Some schools have iPod programs and some may be developing tablet device programs. Although these devices are generally intended for use in the classroom, one of their major benefits is to give students many opportunities to practice outside of class. UNESCO recently developed guidance for educators in developing policies around the use of mobile technologies for learning that can be applied to adult education programs as well (UNESCO, 2013).

Public libraries have the potential to play a supporting role in adult education; most public libraries have provided access to the Internet for decades. The American Library Association (2013) has information and pointers to its own data. The Pew Internet & American Life Project also is useful for learning about library access. Some libraries loan devices, which can provide students opportunities to use the Internet and mobile devices outside of class time.

Policies should ensure that schools and libraries have mobile devices for learning that students can use in classroom settings or borrow. Other policies can subsidize the purchase of mobile devices for students registered in adult education programs. Encouraging or subsidizing wireless connectivity in schools and public libraries will give students access to the Internet to complete their coursework, use OERs to enhance their learning, and access other freely available materials including online textbooks.

III. ASSESSMENT

Many people think of assessment as a test. Although testing can play an important role, assessment is a purposeful process that involves collecting information, analyzing that information, and making decisions on the basis of that analysis. In education, a test is one source of information that is analyzed to inform decisions about student learning and achievement. Other sources include prior learning opportunities; work samples such as papers, presentations, or products; and observations of students as they perform a task, such as rebuilding an engine or conducting a water-quality test.

Just as the sources of information used to inform educational assessment can vary widely, so can the purpose of assessment. In some cases, assessment is used to make summative decisions about the outcome of student learning. For example, end-of-course, term, and unit tests as well as high-stakes tests inform decisions about whether students have achieved the learning outcomes of a course or unit or have earned a credential.

In other cases, assessment is used to make formative decisions. A formative decision can focus on monitoring student progress and requires collecting information on an interim basis. It can focus on identifying misconceptions, misunderstandings, or missing information that is interfering with a student's development of a given concept or skill. In still other cases, formative decisions may consider prior learning experiences or student interests to inform the focus of instruction, the contexts for assignments, or the formation of student work groups. Even given its variety of purposes, assessment relies on two key activities to ensure high quality: collecting information relevant to the purpose and analyzing that information in a way that helps inform intended decisions.

The goals established by the NETP reflect the importance of supporting and improving the entire assessment process.

Overview of National Education Technology Plan Assessment Goals

The NETP establishes five goals for using digital technologies to enhance educational assessment. At a high level, these goals aim to improve the quality of information provided by assessment instruments and to enhance educators' ability to use assessment information to improve teaching and learning.

- The first goal focuses on providing timely and actionable information about student learning that is designed to improve achievement and instructional practices.
- The second goal aims to use technology to improve the quality of assessment materials for both formative and summative purposes.
- The third and fourth goals address opportunities to improve assessment by using technology to improve student engagement and motivation during assessment, particularly by embedding assessment into learning activities and making assessments more accessible by applying the principles of Universal Design for Learning (UDL).

- The final goal recognizes the importance of protecting privacy while also capitalizing on the volume and variety of data that can be collected, analyzed, and shared through digital learning and assessment environments.

Collectively, the NETP assessment goals identify several areas of assessment that are ready for improvement through the application of digital technologies. Although the primary focus of the NETP is on K–12 assessment, the goals are applicable to adult learning. The section that follows explores several roles that digital technologies can play in supporting all aspects of assessment in adult education. Recognizing that a variety of digital technologies are already established and have penetrated educational environments, but also cognizant of the opportunities to develop new technologies, the following section divides recommendations into two broad categories: those that can be implemented in the short term and those that will require long-term development.

Short-Term Strategies and Recommendations

Over the past decade, several initiatives have been launched to enhance educational assessment. Although many of these initiatives have focused on assessment in the K–12 arena, the outcomes of these efforts can be applied to support assessment in adult education. These efforts have included the following:

- New test item types that capitalize on digital technology to measure concepts that are not well measured by multiple-choice and open-response items
- Item banks with large numbers of items and tasks that measure the development of English language arts and mathematics knowledge and skills
- Work samples in digital forms that provide evidence of student achievement
- Diagnostic assessments that provide insight into misconceptions and misunderstandings that students hold and that interfere with their understanding of specific concepts
- Improved accessibility by tailoring the way information is presented to students and how students interact with and respond to assessment items and tasks

Below, each topic is presented in greater detail and its potential application to assessment in adult education is described.

Item Types

NETP Assessment Goal 2 focuses on improving assessment instruments through digital technologies. One area of assessment advancing this improvement is the item types used to elicit evidence of learning from students.

Since the invention of the multiple-choice item type in the early 1900s, educational testing has relied almost exclusively on collecting evidence of student knowledge through open-response short-answer, open-response essay, and multiple-choice questions. Although these item types have been effective for measuring many types of knowledge and skills, it has long been recognized that they do not work well for many important concepts and skills. For example, these item types do not work well for measuring mathematical and scientific concepts and skills such as the ability to produce graphs, perform geometric transformations, or categorize data.

Although it is possible to ask students to produce work samples on paper that demonstrate these and other types of knowledge and skills, scoring such responses is expensive and time consuming, introduces subjectivity, and for large-scale assessments, requires collecting, shipping, handling, and processing large volumes of paper.

In recent years, several efforts have explored using digital technology to expand the range of item types used to measure student learning while also improving the efficiency and accuracy of those measures. For example, in a digital environment a student can be asked to

- produce a graphical representation of a linear function;
- highlight content within a passage that supports a statement or position;
- manipulate images of flora and fauna to produce a food chain;
- create a diagram for a given electrical circuit;
- draw, segment, and shade portions of a rectangle that represent a given fraction; and
- translate a geometric shape displayed on a coordinate plane.

In addition, each of these responses can be scored automatically against predefined criteria to determine whether it is correct, partially correct, or incorrect. If appropriate, criteria can also be defined and applied to classify responses that reflect a misconception or the absence of requisite prior knowledge.

Specifications for several of these item types have been developed by the Smarter Balanced Assessment Consortium (SBAC, 2012). Similarly, the Partnership for Assessment of Readiness for College and Careers (PARCC, 2012) has released several prototypes of innovative item types that will be used to guide the development of its assessment of student progress toward college and career readiness. In addition, Scalise's (2009) taxonomy of innovative item types describes the characteristics of a large variety of item types possible in a digital environment.

Given the wide array of knowledge and skills that adult learners are expected to develop, many of which are not measured well by traditional multiple-choice and open text-based responses, there is great potential to employ new item types to improve the summative and formative assessment of adult learners.

Item Banks

SBAC and PARCC are designing summative and formative assessment instruments to measure student achievement of the Common Core State Standards (CCSS) in English language arts and mathematics. In addition to developing secure tests, these efforts are creating items and tests that are intended to be open-access. For example, SBAC plans to develop more than 44,000 items, approximately half of which will be available for formative and interim assessment use.

Although the SBAC and PARCC items are designed to measure the achievement of K–12 students, it is also important for adult learners to master many of these standards. Given the rigor of these items, they may be a valuable resource for educators who work with adults to develop the skills and knowledge in the CCSS, and they are aligned with Goal 2. In addition, OVAE recently released a report on the alignment of the CCSS with adult education titled *College and*

Career Readiness (CCR) Standards for Adult Education, which will add to the resources available for improving assessment in this field.¹

Because these items adhere to industry standards for interoperability, they can be imported and used in a variety of learning systems that conform to these standards. Together, the content of the items and their adherence to interoperability standards create opportunities to use the items in a variety of instructional, learning, and assessment systems and for a variety of purposes. These include end-of-unit/-course summative assessments, monitoring the development of specific skills and knowledge, and assessing out-of-class learning activities or assignments.

Performances and Work Samples

Neither traditional nor more innovative item types can be used as valid measures of many adult-learner skills for formative or summative purposes. For example, it is unreasonable to use a set of test items to measure the ability to assemble a circuit board, tailor clothing, or replace an alternator.

Given the variety of digital devices available to many adult learners, it is possible to record performances and capture work samples via video or still images to provide more pertinent information regarding the mastery of these otherwise difficult-to-measure skills—an enhancement that is aligned with NETP Assessment Goal 2. For example, as many companies solicit instructional videos from consumers that demonstrate the company's products (e.g., <http://www.youtube.com/user/festoolusa>), a course focusing on automotive engineering could require learners to produce instructional videos for a variety of repairs.

Although the logistics for collecting, sharing, and analyzing videos and other media that capture work samples or performances require careful thought, a variety of tools support these processes. For example, both YouTube and Google provide open access to video uploading and sharing. Similarly, learning systems such as Blackboard, Moodle, Desire2Learn, and the National Training and Education Resource (NTER) offer more structured tools for submitting media-based work samples, reviewing those samples, grading, and providing feedback to learners as parts of the online learning opportunity.

Diagnostics

NETP Assessment Goal 1 seeks to provide educators with actionable assessment information. As described here, diagnostic assessments accomplish this goal by providing information about specific misconceptions or misunderstandings that interfere with a student's understanding of a specific concept.

Many adult learners have experienced interruptions in their education that could contribute to misconceptions, misunderstandings, or missing information about a particular concept. Traditional achievement tests, either formative or summative, provide information about the extent to which students have understood or mastered a given concept or set of concepts. Poor performance on traditional achievement tests might indicate the need for additional opportunities for learning. However, little information is provided about why some students are struggling.

¹ The *College and Career Readiness (CCR) Standards for Adult Education* report can be found at <http://lincs.ed.gov/publications/pdf/CCRStandardsAdultEd.pdf>

To provide more sensitive and instructionally relevant information, efforts have been made to develop items and tests that offer more information about the cognitive misconceptions and misunderstandings of poorly performing students. Specifically, these tests present students with items that, answered correctly, support inferences that the students understand the concept. However, answered incorrectly, the same item can be used to make inferences regarding whether the students seem to have a misconception or misunderstanding specific to the concept being measured (Masters & Chapman, 2011).

For example, when studying algebra and the concept of equality, many students hold a misconception about the conceptual representation of =, the equal sign (Russell, O'Dwyer, & Miranda, 2009). Instead of thinking of the equal sign as a representation of equality, such that both sides of an expression have equal value, some students conceive of the equal sign as an instruction for performing a mathematical operation. This misconception stems from the use of the same sign for arithmetic problems, for which students are asked to solve for the value that is equivalent to the expression ($4 + 5 = \underline{\quad}$). By carefully constructing items that measure an understanding of equality, Russell and colleagues have demonstrated that student responses can be analyzed to determine whether they make errors that result from treating the equal symbol as an instruction to perform an arithmetic operation, whether they make some other error, or whether they interpret the meaning of the equal sign appropriately.

The development of cognitively diagnostic assessments is still in the early stages. Nonetheless, the varied and sometimes incomplete prior learning opportunities of adult learners merit a careful assessment of their cognitive understanding and the potential application of misconceptions. Although diagnostic items could be included in a summative assessment, they are intended for formative purposes. In some cases, diagnostic assessments are useful for assessing prior knowledge before instruction begins. When a new concept is introduced, diagnostic assessments are helpful after learners have been exposed to instruction or learning activities.

Accessibility

NETP Assessment Goal 4 aims to apply principles of UDL to improve the accessibility of assessment instruments for all users. Over the past decade, approaches to supporting accessibility in the context of assessment have evolved rapidly. Whereas accessibility needs were once linked to a particular disability and met through accommodations after a test was developed, it is now recognized that accessibility is not limited to people with disabilities. In addition, whereas accessibility was once thought of as a shortcoming within students that interfered with their ability to access the information presented in an item, accessibility in the context of assessment is now thought of as a two-way communication in which test developers present information to activate within students the knowledge or skill being measured, students interact with content in the item as they apply the knowledge or skill being measured, and finally students communicate the outcome of their cognition through their response to the item (Russell, 2011).

Just as the sophistication with which test developers approach accessibility has increased, the methods through which accessibility is achieved have embraced the concept of flexible test delivery. At its core, flexible test delivery matches individual accessibility needs with specific methods of presenting, interacting with, and responding to items. For example, for students with vision-related needs, a digital test delivery environment can present items in a magnified form or

alter the contrast with which the content is presented. Similarly, for students who need assistance decoding text, a digital delivery system can present information in both text-based and spoken audio forms (assuming that the test is not measuring the ability to decode text-based content). As another example, for students who are unfamiliar with words or phrases in an item, a digital delivery system can have pop-up glossaries or translations (assuming the test is not measuring understanding of that vocabulary). In effect, the flexible delivery of assessments aims to increase the validity of measures by reducing the influence of skills and abilities that are not the object of measurement.

To support the accessibility of digital assessments, several states collaborated with industry leaders to develop the Accessible Portable Item Protocol (APIP) Standard (IMS Global Learning Consortium, 2013). As an industry interoperability standard, APIP establishes a structured method for embedding supplemental information in a digital item that meets specific accessibility needs. For example, APIP provides methods for embedding specific information about how content, such as mathematical functions, should be presented in spoken form; how text-based content should be presented in braille, American Sign Language, and other languages; and which terms should be presented to students unfamiliar with a given word or phrase in an item.

Currently, tailored delivery of accessible assessments is a core component of the Race to the Top Assessment consortia and has been adopted by several state assessment programs. In addition, an increasing number of delivery systems are integrating methods that support the flexible delivery of accessible assessments. Given that a substantial portion of adult learners may have one or more accessibility needs, the tailored delivery of accessible assessments and assessments that conform to the APIP Standards may improve the quality of information used to make summative and formative decisions about adult learners.

Long-Term Strategies and Recommendations

Several developments outside the educational arena hold promise to enhance educational assessment. Specifically, methods used by companies such as Amazon, Google, and Facebook to track data about the content viewed by consumers and the products they purchase, and the “big data” analytic methods used to predict behaviors, tailor messages, and create social networks could have powerful applications to educational assessment. Two specific opportunities are described below: peer matching and the prediction of useful learning opportunities. Both are aligned with NETP Assessment Goal 5, which focuses on the ongoing gathering and analysis of data to improve teaching and learning.

Peer Matching

Online and distance learning have increased rapidly over the past several years. It is difficult to determine how many students are engaged in formal online learning opportunities. Nonetheless, several states have adopted online courses for K–12 students, increasing numbers of districts have made professional development available to educators in online environments, and many universities are offering instruction through MOOCs. Although the online delivery of courses and professional development provide more flexibility in terms of when and where students engage with course material and increase access to quality learning opportunities, retention rates

for online learning have generally been lower than for more traditional face-to-face instructional environments.

Peer matching is one approach with the potential to improve retention rates while also increasing support for learning in online environments. Peer matching focuses on connecting pairs or small groups of students who are likely to support one another's learning. For example, a student who is having difficulty understanding a concept, perhaps because of a misconception, is matched with a student who has mastered the concept. Through this matching, students who demonstrate mastery can deepen their understanding by exploring different ways to help struggling students overcome misunderstandings, misconceptions, or lack of prior knowledge. In another example, peer matching connects students who are performing at similar levels or who have similar interests or targeted characteristics. Peer matching for a mathematics course might create one peer match that is based on two students' interest in electrical engineering and another peer match based on two students' interest in culinary arts.

Depending on the purpose of matching, a variety of information can inform peer matching, including prior performance in the current or other courses, performance on tests, diagnostic test results, interest inventories, demographic information such as first language, and other information about interests and habits. Although educators have been creating peer matches in traditional face-to-face classrooms for decades, the quality of those matches has been limited by the relatively small number of students in a given classroom and the availability of relevant information. In online learning environments, however, large numbers of students and their increased diversity offer opportunities to form richer peer matches. This is particularly true for MOOCs, which often have hundreds to thousands of students.

Although there is not yet a rich research base to inform the data and methods used to form and support peer matching in online learning environments, peer matching has the potential to support adult learning by creating stronger bonds among adults participating in a given course, increasing opportunities to learn and articulate understanding, and strengthening the connection between course content and its potential applications in the workplace.

Learning Opportunity Tracking and Analysis

The course of study for some adult learners occurs in a less structured and sequenced manner than for most K–12 and postsecondary students. In addition, adult learners are more transitory with respect to both where they reside and where they seek learning opportunities. Together, these factors create challenges to informing instruction based on prior learning opportunities and prior knowledge.

Many commercial entities have established methods for tracking the information and products an individual has been exposed to. This information is then used to identify new information or products that interest the individual.

Although it has not yet been explored in the area of education, creating digital records of learning opportunities for individual learners has great potential to inform future learning opportunities. For example, the growing interest in portable learner profiles means that adult learners can manage information about their learning and achievements while personalizing their records beyond what each school might track (Bailey, Casey Carter, Schneider, & VanderArk,

2012). In the simplest form, a digital record of learning opportunities can be limited to a record of courses and training sessions in which learners have participated or that they have completed. More sophisticated approaches will also track information about specific learning tools accessed by students, including sections of digital texts, instructional Web pages, content-specific videos or audio files, and webinars. Collectively, this information can be analyzed to identify gaps in learning opportunities, identify information or concepts that learners are prepared to learn, or predict learning resources of interest to specific learners. This information can also be used to identify learners' areas of interest, which can then be used to inform peer matches.

This approach to learning opportunity informatics requires a considerable investment in developing the data structures required to encode information about learning opportunities and the infrastructure to record such information for each individual. This approach also entails careful consideration regarding the formation of accounts for each learner and the way information is associated with that account. Nonetheless, given the transitory nature and unstructured pattern of learning opportunities for some adult learners, methods of tracking these opportunities—regardless of their location—hold great promise for improving the quality of data about earlier learning opportunities. In addition, developing methods that use information about prior learning opportunities to help structure future opportunities has the potential to create a more tailored, personalized learning trajectory for every individual adult learner.

Implications for Policy and Practice

The short-term opportunities described above draw on tools and resources that already exist or are currently in development. These short-term opportunities are also aligned with current policies; thus, they do not require the modification of policies regarding the assessment of adult learners. However, the appropriate use of these resources may require training the educators.

In contrast, long-term opportunities rely on collecting and analyzing data—some of which may be viewed as personal. For example, tracking resources accessed through the Internet can be considered an intrusion on privacy, particularly if these resources are accessed beyond a formal learning setting. However, knowing what information and learning resources a person has accessed can provide insight into learning opportunities and may inform whether a learner has had sufficient exposure to content before assessing his or her knowledge or understanding of that content. Given the potentially sensitive nature of such data, policy regarding the appropriate collection, access to, and use of those data will need to be developed. In addition, educators will need to be trained regarding the appropriate use of the information these data yield. Finally, security protocols that protect access to the data must be developed. As noted in other sections of this report, the e-portfolio is another tool that learners can use to track their learning and achievements.

IV. TEACHING

Adult education teachers can be full-time employees of a school or community college, but more likely they are part-time employees who may teach in a variety of locales, have part-time employment in addition to teaching, or have significant family responsibilities. The kinds of recommendations that could be made for teachers who are full-time employees do not easily apply to part-time adult education teachers. For example, part-time teachers generally do not have the kinds of merit pay incentives that full-time employees have to update and improve their skills; they likely are not contractually obliged to participate in ongoing professional development. If they want to improve their skills because of their own desire for improvement, there may be no opportunities to participate in free professional development activities in their current environment. If adult educators are to develop new pedagogical and technology skills, careful thought must be given to goals, incentives, learning materials, and technology infrastructure.

The NETP has two main goals associated with teaching: prepare and connect. These goals are certainly applicable to adult educators, but challenges to achieving them are likely to be greater than for teachers who are full-time employees of an educational institution. The online environment offers the flexibility to reach part-time teachers when it is convenient for them, but it presupposes their motivation to connect to professional development opportunities and the availability of a robust Internet connection and learning environment (at home or in the office) where teachers can spend time on learning activities for themselves. A successful preparation program gives teachers opportunities to improve their pedagogical skills and learn about and practice using new technologies while helping them understand and practice a variety of technology-enabled pedagogies.

The goal of connecting, as it relates to instruction, involves connecting to teaching materials and communities of practice. A huge amount of online learning content exists today, but finding appropriate materials by subject, level, pedagogical practice, and other criteria remains challenging and time-consuming. Strategies to help teachers locate peer-reviewed or highly recommended resources for adult education minimize the time needed to identify appropriate content and professionally evaluated resources.

The Internet environment presents many opportunities for connecting people through social networks, specifically within communities of practice, which offer an opportunity for adult education teachers to interact with their peers, mentors, and specialists in various areas. All these possibilities exist in both theory and in practice, but many teachers are bewildered by the overwhelming variety of choices and have no idea how to begin. They may also lack experience with social networking or a community with which they identify. Both opportunities and barriers to progress exist for connecting teachers with content and people.

Short-Term Strategies and Recommendations

Several short-term strategies are relevant for teachers in the adult education field. Examples are presented below, along with recommendations for achieving them.

Professional Development

Like students, many adult educators benefit from professional development in a blended learning setting. Many universities offer education courses that address a range of needs. Adult educators can participate in formal education programs, either taking a limited number of courses or progressing toward a master's or doctoral degree, in a blended learning environment. Adult educators should be encouraged to update not only standard pedagogical theory but their technology skills in such areas as searching for information, creating content (e.g., wikis and websites), and producing multimedia (e.g., podcasts and short videos). Activities can be built into the curriculum of their courses or workshops; in the blended, online component of the educational experience, they can practice new skills.

Adult educators who are not taking full courses benefit from workshops, tutorials, and practice sessions to master new technologies. These can take place in in-person, blended, and fully online settings. Incentives will likely increase teachers' participation. It is possible to use incentives that do not incur actual costs, such as awarding certificates that document the attainment of a specific set of skills. Incentives can also be developed for adult educators to increase their pedagogical and technological skills in formal educational programs.

Course offerings—a mixture of in-person, blended, and fully online offerings that best suit the learning preferences of a range of individuals—must cost adult educators little or nothing and accommodate their schedules. Short-term online support can be built into such workshop offerings to provide additional guided practice time after the formal workshop.

Open Educational Resources

A number of government agencies and foundations support the development of OERs, defined in the Learning section. OERs include full courses, course materials, modules, textbooks, videos, tests, software, and tools. Creating educational resources is not free, but ideally the authors receive some type of institutional support and the teaching materials are freely available to all. These kinds of resources have created a revolution in teaching and learning.

Unfortunately, many collections of OER materials are underused because the potential audience either is unaware of their existence or finds that locating the OER materials needed for particular curricular needs is too difficult and time-consuming. Information professionals and others can determine how to make these resources more usable and develop marketing strategies to ensure that potential users are aware of these sites. For example, a major resource, OER Commons, tags items as “adult education,” but users cannot choose that category for “level,” which would be a more efficient approach for adult educators.²

Information professionals can help determine more effective modes of providing metadata for OER materials suitable for adult education programs and issue a set of best practices. Professional groups can develop mechanisms (e.g., portals, websites, wikis) that identify effective OER materials for subgroups of adult education (e.g., basic literacy, numeracy,

² OER Commons recently added “adult education” as a tag and is considering adding in the near future “Adult Education” as a level within its evaluation schema and “Adult Basic Education” and “Adult ESL” as subcategories.

citizenship). Professional conferences and workshops attended by adult educators are good venues for promoting OER sites.

Social Networking

A number of social networking venues for educators already exist. For example, LINCS (<http://lincs.ed.gov/>) is a federally sponsored community for adult educators that provides Web-based professional development, educational resources, and an online community. The U.S. Department of Education has also created the resource *Connect and Inspire* about communities of practice (<http://connectededucators.org/report/>).

Teachers in adult education might take inspiration from colleagues' blog posts, such as those by a teacher of Bio 101 for adult education, whose assignments include many technology-based and social networking aspects (<http://goo.gl/8oDjW>).

Although providing social networking sites for teachers to form communities of practice does not present technical challenges, it is unclear how well prepared many adult education teachers are to use social networking technologies. Because many adult educators are part-time instructors (perhaps with other jobs or family responsibilities), they may find it difficult to justify the time needed to actively participate in an online community of practice.

A needs assessment can uncover the preferred modes of connecting educators to people. Programs that provide a social networking experience can directly follow a workshop or professional development experience. Tying the social networking community to a specific topic or event in which teachers have participated can stimulate interest and provide a means for clarifying issues once they have the opportunity to try out what they learned. Professional conferences and workshops are effective sites for promoting communities of practice through flyers, poster sessions, and informal discussion groups.

Long-Term Strategies and Recommendations

Significantly rethinking pedagogical models is a huge challenge; many critics of U.S. education have noted that the way schools have operated over the last century has shown much less change than almost any other societal institution. Teacher preparation, both in schools of education (for new teachers) and in continuing education, must help teachers radically rethink their pedagogical methods by exposure to the possibilities that new technologies offer. Technologies themselves are not the solution to problems in education, but they are a means to offer radically new modes of teaching and learning.

Adult education teachers face many challenges, including students at widely varying levels in the same class and students with different language skills and educational backgrounds. One way to approach adult education is to consider how to deliver the core content of a course without focusing all or the majority of the teacher's time in that activity, freeing the teacher to do more one-on-one coaching and tutoring in a class setting. Teachers should be assisted in preparing for new instructional modes, such as blended learning, the flipped classroom (where students watch teacher-recorded video lectures before class and use in-person class time for collaborative, problem-based learning), and other innovations. Teachers can find existing educational resources on the Web and create their own. However, many need to develop the requisite skills to fully

participate in the Internet educational environment. They also need to be able to easily find digital content of all kinds that they can use in their teaching.

Another approach is to develop programs that include full curricula for standard adult education content in one of the basic areas of language skills and mathematics, perhaps based on or informed by the CCSS. Such a program can contain online modules for each component of the instructional objectives, tying into a diverse set of content (e.g., videos, podcasts, games) and tracking student progress. Students progress through the materials at their own pace and attend in-person classes for both individual tutoring and mentoring and for select group activities such as conversational English or collaborative, multimedia assignments. Programs' development of full curricula is likely a long-term goal, but components of such curricula could be made available sooner.

Incentives can be offered to encourage programs to dramatically rethink adult education curricula and modes of delivery, emphasizing curricula that are individualized, differentiated, and personalized (as described in the Learning section). Educators around the country have many opportunities to provide a variety of models. There is no “one size fits all,” but the desirable outcome here is to develop some standard curricula supported by learning materials in a small number of subjects and at relatively introductory levels for adult learners. This type of curriculum, with agreed-upon basic content objectives, whether through CCSS or professional association standards (e.g., National Council of Teachers of Mathematics standards at <http://www.nctm.org/standards/>), is an excellent candidate for an overall curricular approach. At present, many disparate elements of curricula are online, and it is difficult for teachers to assemble these materials into a cohesive whole. If entire programs are available for some core subjects, teachers can focus on working with students. Also, a large number of students using the same curriculum can provide a population that enables the study of effective practices. The National Research Council 2012 report *Improving Adult Literacy Instruction* notes the need for more research-based instructional materials, which would help teachers deliver evidence-based instruction that supports improved student learning.

Implications for Policy and Practice

The general availability of good broadband access to the Internet is essential if teachers are to participate in blended learning opportunities as students (in courses or professional development activities) and to find and use existing online resources in their own curriculum development. Internet2 is also playing a role in connecting communities—and libraries—to high-performance networks (http://www.infoday.com/cilmag/nov07/Werle_Fox.shtml).

OERs will enable teachers lacking good financial support from their educational programs to use high-quality online materials without a fee. When government funds the creation of educational materials, it should require that those materials be available as OERs, free of charge. In the area of scholarship, there is precedent in the Open Access policies of the National Institutes of Health and in the Obama administration's support of open-data policies.

The Hewlett Foundation (<http://www.hewlett.org/programs/education-program/open-educational-resources>) and others support the creation of OERs. The government can encourage continued investment in freely available materials by developing matching programs with private

fundings as well as directly funding the development of OERs. California is currently funding OER textbooks for the 50 most popular, lower-level higher education courses (<http://creativecommons.org/weblog/entry/34288>).

V. INFRASTRUCTURE

Realizing the potential to transform education as outlined in the NETP requires a robust infrastructure for learning with both human and technological components. This infrastructure removes barriers and enables learning via people, resources, processes, policies, and sustainable models for improvement; it includes access to a digital environment that has broadband connectivity, advanced server architecture, current software, management systems, and effective administrative tools.

Ideally, the infrastructure is “on” at all times. This expectation is essential for success in adult education, considering the time constraints of adult learners who are often full-time workers. Another challenge is that adult learners are likely to engage in a variety of formal and informal educational experiences that involve different academic systems, institutions, and courses as a prelude to, or instead of, enrollment in a single academic program. So the infrastructure that effectively supports adult education must track and provide access for adult learners with changing affiliations. A comprehensive infrastructure will be able to support lifelong and life-wide learning by connecting people with one another and with resources, anytime and anywhere, and even enhance adult learners’ performance in their current employment. This infrastructure must also be flexible as technology advances, particularly in education, where predictions for the predominant technologies in the next several years have already become a reality (Johnson, Adams, Cummins, & Estrada, 2012).

The NETP calls for all students and educators “to have access to a comprehensive infrastructure for learning when and where they need it” (NETP, 2010, p. 51). Although there are a number of specific recommendations, broadband, wireless, and device access is essential to ensuring that all learners have the means to fully engage in online learning opportunities. Interagency collaboration at the national, state, and local levels is needed to improve access. Following are short- and long-term recommendations specifically for improving Internet access for adult learners.

Short-Term Strategies and Recommendations

Several short-term strategies are relevant for the adult education field. Examples are presented below, along with recommendations for achieving them.

Connectivity

Connectivity is foundational to leveraging technology and expanding access to digital content for adult learners. Unfortunately, access to a broadband network and Wi-Fi can be too costly for some people or simply unavailable in certain densely populated urban centers and sparsely populated remote areas. The National Broadband Plan includes communitywide access strategies and can have a profound impact on adult education. In the meantime, offering stipends and discounts to adult learners to purchase services and providing financial incentives to service providers for adequate, affordable coverage can remove barriers to Internet access. Another possibility is the development of an E-Rate such as that available to schools. Internet2 can also play a role in connecting communities to high-performance networks through partnerships with public libraries, which have a decades-long history of providing Internet access.

Cloud Computing

The NETP refers to cloud computing as “next generation architecture” that offers a potentially cost-saving alternative to supporting a local infrastructure of servers and services. Cloud-based services and resources provide anytime, anywhere access to digital content, applications, and services. Adult learners can create their own low-cost personal learning environments by combining readily available, often low-cost technologies that support collaboration, communication, and content creation (e.g., Skype or Google Hangouts for videoconferencing; Google Docs for collaborative writing; DropBox for file storage and sharing; a \$5 iPad app for video editing). Educators can also use cloud-based services to create content, assessments, interactive activities, and whole courses that can be accessed from anywhere at any time. In removing obstacles to access, the learning infrastructure can leverage the delivery and distribution channels already familiar to many adult learners: YouTube, iTunes, and possibly social networks. These online spaces are familiar to many and lower one barrier to access.

Human Networks and Technical Support

Current research is identifying the learners best positioned to benefit from new online academic offerings such as MOOCs. These students are often highly self-motivated. Other adult learners improve their chances of completing and achieving learning outcomes when they have person-to-person connections while engaged in online learning. Success factors for online learning include the presence of an instructor, interaction with peers, and regular feedback; these factors have been related to higher rates of retention and completion in online courses. The learning infrastructure enhances learning outcomes by providing teaching teams, mentors, and coaches who can offer support and formative feedback to adult learners.

Online learning and digital environments present new opportunities and require different skills. The learning infrastructure could also improve student and educator readiness by providing general training and skill development in technology competencies, multimedia literacy, and productivity and presentation software, as well as a basic introduction to best practices for teaching or learning online. The role of libraries can expand to support adult learners by becoming satellite locations with computer access, loaner mobile devices, and “genius bars” where technical questions are welcome and other teaching, learning, and research support is available. A similar source of support can be established and made available virtually.

It is likely that new roles will emerge to support and facilitate lifelong learning and leverage digital learning spaces. Imagine a lifelong learning advisor whose goal is to assist unaffiliated adult learners in creating a “learning plan” that helps them navigate and choose academic experiences that support their individual learning goals. Ideally these plans will be applicable to different academic programs, courses, and experiences. Students who are enrolled in an institution or program often have access to academic advisors, but adult learners who are participating in different offerings benefit from an unaffiliated professional who can help create a “learning roadmap.” Undergraduates and high school students could become valuable resources by serving as technical support advisors, either as volunteers who earn credit and other recognition or as paid staff or interns. The flexibility of being able to provide support virtually would also attract students to these kinds of roles and offer a scalable support solution for adult learners.

Long-Term Strategies and Recommendations

Devices and software are also necessary to realize online learning opportunities. Partnering with vendors and offering incentives to employers to provide discount purchasing, loaner, and trade-in programs for laptops, tablets, and mobile phones may lower costs and provide an alternative for distributing software and devices. The infrastructure will also benefit employers by developing their employees' technical competencies and facility with common productivity applications. Given the high rate of mobile phone ownership, developers should be encouraged and offered incentives to develop educational content, software, and services for mobile access.

A long-term goal for the infrastructure is the development of learner-centered records. These digital records would resemble transcripts in that they reflect a student's academic history; they would be different in that they capture both formal and informal learning experiences and competency assessments and provide a learner profile that follows an adult learner through different programs, institutions, courses, and informal academic experiences. E-portfolios that demonstrate and showcase skills and achievements and recognize nontraditional learning outcomes can be incorporated into or associated with such a learner-centered record. Another way to capture, communicate, and demonstrate adult learners' knowledge would be through the use of digital badges. These badges could represent different levels of work and engagement, including more granular, specific skills or achievements. This approach would support and validate adult education and learning that takes place across a broad spectrum of academic offerings and digital learning environments.

Implications for Policy and Practice

Open online learning environments, mobility, and access to free educational resources raise several issues related to the security, privacy, and ownership of intellectual property. It will be important for online educators and learners to understand the policies and laws related to fair use and copyright. Educators and learners must review the contractual agreements that accompany free services so they fully understand what rights they are sharing when it comes to accessing and using content. Although cloud-based computing is attractive in that it shifts operational responsibility and reduces local costs, consumers need to know the extent of each service provider's commitment to disaster recovery, downtime, and business continuity.

MOOCs and other emerging models for delivering academic content pose the challenge of accreditation. Efforts are being made to develop new and acceptable approaches to assessing competencies and skills acquired beyond traditional, accredited academic programs. Developments in this area have an impact on adult education that is likely to continue to cross the boundaries of institutions, both on the ground and online. OERs pose a similar challenge in terms of assuring consumers that the information and resources are credible. Ensuring a review and "seal of approval" for educational materials leads to major difficulties in terms of scalability. A best practice for authors might be to tag content with citations and references that learners and educators can search to enhance credibility.

Final challenges are access to the Internet and, to a lesser extent, devices. The concept of net neutrality continues to be debated when it comes to service providers controlling access to the Internet and maintaining a viable business model. Like textbook publishers, Internet service

providers are feeling the pressure of changing consumer behavior and an educational system that increasingly depends on Internet access to meet the requirements of quality education in the 21st century. Employers who require different competencies for their workers in an information age will have to join the conversation and contribute to a solution that ensures community and regional access to the Internet. Otherwise, the educational opportunities afforded by a digital learning environment will be limited to adult learners who can afford to purchase that access.

VI. PRODUCTIVITY

A measurable goal of the NETP is to increase the percentage of U.S. citizens holding college degrees from 40% to 60% and to do so within current resource constraints. The NETP also expresses a commitment to continuous improvement while holding the line on increasing resources and investments directed to education. It will be essential to leverage technology not only to advance learning but also to track outcomes against investments in time, staff, and dollars. If decision making is going to be data driven, these metrics will have to effectively measure the efficacy of both the pedagogical approaches and technological solutions used by students, instructors, and administrators in adult education. Continuous improvement depends on both types of data to support a cycle of implementation and refinement.

The NETP describes several approaches that will have a transformative effect on adult education by supporting flexible, student-centered learning. Developing a performance-based system that requires a demonstration of competence versus seat time, uses self-based versus time-based measures for course participation, offers customized learning that acknowledges preexisting skills and knowledge, and provides 24/7 access to a learning infrastructure will increase academic success for adult learners. These recommendations provide a long-term vision of adult learners who will use a customized learning plan to choose from diverse academic opportunities and a digital portfolio to capture assessment, recognition, and evidence of their competencies and academic achievements.

Short-Term Strategies and Recommendations

Several short-term strategies are relevant for the adult education field. Examples are presented below, along with recommendations for achieving them.

Content Interoperability

The market for online adult education instructional materials is not large enough to command a significant investment from commercial publishers. Many of the programs available have been rebuilt and refashioned from print or early computer-based instruction programs. One solution to this problem would be the adoption of open standards that define the format for the distribution of rich, Web-based content.

The Sharable Content Object Reference Model, or SCORM, is a standard for deploying standalone computer or Web-based training materials. For example, when developers create digital course content and publish it as SCORM compliant, they ensure that any modern learning management system can import, launch, plan, and track information related to that course.

Common Cartridge is a specification that describes the format for creating and sharing educational digital content; its use solves several problems. The first is that it provides a standard way to represent digital course material for online learning systems so that such content can be developed in one format and used across a variety of learning management systems (e.g., Blackboard, Moodle). The second is that it enables new publishing models for online course materials and digital books that are modular, Web distributed, interactive, and customizable.

Another advantage of Common Cartridge is that it was developed primarily to support the use of digital content in an instructional context. As the online delivery of adult education content matures, there will be a greater need for managing disparate content, assessments, and collaborative environments. Embracing the SCORM and Common Cartridge standards for adult education digital content will offer a pathway to ensure interoperability with the most common learning management systems.

Flexible Course Formats and 24/7 Access

Like all adults, adult learners are busy with family, work, and community responsibilities. Very few have the luxury of daily attendance in brick-and-mortar classrooms. Adult education programs need to more fully explore and implement online and blended learning solutions that offer greater access and increase and extend learning time.

Technology tools enhance productivity by enabling educational programs to expand capacity with administrative and structural innovations, such as rolling admissions and cohort groups. Adult learners benefit from a greater variety of rigorous but flexible alternatives, such as brief, short-term, self-paced, and hybrid or blended courses. One example of this approach is the movement of community colleges to offer just-in-time training. These academic offerings increase retention, engagement, and successful completion by providing clear learning objectives, frequent feedback, and immediate assessment of learning outcomes and competencies. One challenge is to strike the right balance of technology and human intervention in instruction, technical support, and course administration.

A significant advantage of online learning for adults with varied schedules is technology that offers 24/7 access to self-paced course content and self-help resources. It is important to combine the do-it-yourself approach that automates and customizes learning with access to personal academic and technical assistance. Retention, engagement, and academic success have been positively correlated with online presence and support; students value the availability of and (occasional) contact with instructors, experts, coaches, mentors, or course leaders (<http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf>). The synchronous human touch still makes a difference, especially for learners new to online learning.

Social Learning Opportunities

Research indicates that social learning can have a positive effect on individual learning outcomes and academic success (<http://www.plosone.org/article/info:doi/10.1371/journal.pone.0055944>). Collaboration, communication, and social networking tools support social learning networks. MOOCs, which encourage students to engage with one another, originated as an experiment using large-scale human networks to harness the power of collective intelligence. Social networks are a means for adult learners to connect with one another and with experts in their fields. They serve as a constant online presence that provides peer support; instructors also use them to engage learners in peer feedback and assessment. Research in online communities indicates that there is a role for a facilitator who maintains connections with network members and reinforces the value of participation.

Networks such as LinkedIn enable contact with experts, mentors, and prospective employers as well as with successful adults who are on a similar professional pathway. Adult education can take this contact a step further by developing a network of nonaffiliated, validated sponsors, mentors, employers, and organizations that offers opportunities for experiential learning. Such a network benefits adult learners who are not enrolled in a program with formal internship opportunities. It benefits employers and increases productivity by providing a pool of adult “interns” who learn to meet their job requirements and strengthen the workforce. This approach also encourages the private sector to invest in employee education.

Evaluation of Strategic Investments in Services and Functionality

Assessing the efficacy of a technology that supports teaching and learning starts with establishing learning outcomes and a plan for how the technology is expected to help learners gain knowledge, apply concepts, develop skills, change attitude, or create a learning artifact. The NETP suggests that assessing the value of a technology investment should rely on data that indicate how a technology is used and what impact it has rather than on its cost. Technology is one component of a learning ecosystem that involves elements such as course design, opportunities for interaction, feedback, contact with instructors and peers, and technical and academic support. Establishing a cycle of implementing and refining education practices and applications of technology for adult learners requires ongoing evaluation in different contexts over time.

Open educational resources offer great promise in terms of cost savings for adult education, either as stand-alone experiences or as complements to traditional course delivery. It is essential to assess the effectiveness of the underlying pedagogies and technologies of an OER. Educators need to analyze a combination of metrics that describe pedagogical, technological, and programmatic approaches. Achievement of competencies, ease of use of an interface, course retention and completion, employability and transfer of skills and knowledge to the workplace, capacity for ongoing skill and knowledge development, and technology performance and scalability are all valid measures of success and indicators of the return on investment for developing courses and providing access to the Internet, computers, and mobile devices.

Long-Term Strategies and Recommendations

Unified Record of Learning, Skills, and Achievements

Going forward, U.S. education statistics will need to redefine an “educated and competent” workforce on the basis of measures other than graduation from traditional accredited institutions of higher education, and in a way that aligns with workforce needs. Adult education draws learners who have already entered the workforce but want to complete or further their education within the PK–16 system; it also includes graduates who are entering a new field or building on their existing degrees, and increasingly it includes adults who seek to increase specific skills and knowledge without the goal of attaining a degree. Many of these adult learners take advantage of new online learning and experiential learning opportunities outside of, or in combination with, traditional academic systems. Acknowledging and crediting their academic achievements will increase the count of competent and educated U.S. citizens.

Because adult learners may drop into and out of one or more educational programs, a unifying record must be created to capture different certifications and credits and provide a single learner profile and assessment of achievement and credentials. Learner profiles that include a system of digital badges (see Infrastructure: Long-Term Strategies and Recommendations) could enable adult learners to capture and identify their formal and informal experience, competencies, strengths, skill gaps, and learning goals. A digital profile can be shared among instructors, learning institutions, and industries.

Data and Analytics

Data and analytics must be used effectively to track learner progress, identify at-risk learners, conduct interventions, and provide scaffolding that guides learners to additional help as needed and in a timely manner. Dashboards are especially useful for supporting learners who are not used to self-paced learning. Imagine a tool that monitors participation in a course and sends reminders when a period of inactivity is detected. Ideally, a responsive system helps students become aware of and reflective about themselves as learners. Dashboards, learning management systems, and interactive educational technologies support the customization of learning and enable adult learners to develop competencies through skill practice, feedback, and assessment. These systems are also a great source of data that can be used to refine learning designs and implement programs.

Analytics that focus on the “big” data contained in enterprise systems also have the potential to support the continuous improvement of learning design and technologies in adult education. However, according to the NETP, storing data in silos creates barriers. So making informed, data-driven decisions will depend on the development of interoperability standards and tools that enable data to be pulled from different systems and combined for analysis. This may include learner outcomes already tracked in the adult education program, including improvements in literacy skills as well as employment, secondary, and postsecondary attainment. Learning management systems track how adult learners interact with content, resources, services, and people. Data also indicate how users interact with an interface (e.g., how they navigate through a site to find information) and can help improve usability.

A mobile, digital transcript developed according to interoperability standards will be a highly useful technology solution. Such an application will provide the profile of an adult learner and a unified record of his or her learning experiences and assessments of competencies in the form of credits and certifications. This tool will be particularly valuable for adult learners who are navigating a vast landscape of formal and informal, on-the-ground and online learning opportunities.

Implications for Policy and Practice

The overarching goal for improved productivity is that new course formats and transformative change lead to the optimization of funding, staff resources, and time; the improved achievement of learning outcomes; and the increased demonstration of competencies. Meeting these goals poses a policy challenge regarding the assessment and accreditation of learning that occurs across a variety of learning environments and institutions.

CONCLUSION

The 2010 NETP outlines a vision for using technology to enhance teaching and lifelong learning. It calls for innovations that will transform education and ultimately lead to the fulfillment of President Obama's goal for the United States to become more globally competitive by closing the education achievement gap and increasing college completion rates. By helping the nearly two million students currently enrolled in adult education programs meet their career and academic goals, the adult education field will play a significant role in answering the charge of the Obama administration (U.S. Department of Education, 2009).

Actualizing the vision of the NETP also has the potential to help the adult education field address the need for increased infrastructure and capacity to meet the demand of the nearly 40 million people who are in need of adult basic education but are not served (Lasater & Elliott, 2005). The opportunity to achieve national goals and to better serve more students through the application of the NETP was the impetus for this report, which proposes both short- and long-term recommendations specific to adult education in the five areas addressed in the NETP: learning, assessment, teaching, infrastructure, and productivity.

The implications of the recommendations offered in this report hinge on policy and programmatic action that will transform adult education to a digitized learning environment and make educational resources, which include learning objects, tools that support learning, and data on student learning, more accessible to educators and adult learners. To implement the NETP in the adult education context, greater access to educational technology that provides more opportunities for student learning is needed. This can be done by helping adult learners gain Internet access either through mobile technology or an infrastructure that supports unrestricted Internet use for students. The plan also requires increased access to high-quality educational resources, such as open education resources (OERs) for teaching and assessments for evaluating student learning and competencies. To support the vision of the NETP in adult education, these resources must (1) have no barriers to their use; (2) be free to educators and adult education programs; (3) and be organized in a meaningful manner enabling easy access for a specific purpose. Finally, approaches to teaching and learning must be transformed to allow the full realization of educational technologies and to leverage their use for both independent and social learning.

In the spirit of empowering adult learners and educators by means of technology, the recommendations presented in this report support wide and unobstructed access to the tools and resources needed for students, in the tradition of adult education, to take charge of their own learning. Implementing many of the recommendations will require collaboration among stakeholders over a long period of time. However, many recommendations that would improve the quality and availability of educational services to adult learners could be enacted in the short term and with limited expense. These recommendations have the potential to provide the basis for new thinking about technology in adult education, broadly influence changes in practice, and move learners and educators closer to the "personalized learning" and "connected teaching" envisioned in the NETP.

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ADDENDUM, JUNE 2015:

In May 2013, the *Connected Teaching and Personalized Learning: Implications of the National Education Technology Plan (NETP) for Adult Education* was released for public comment. As a response to the 2010 National Education Technology Plan (NETP) the report outlines a number of implications for the adult education field within the themes of learning, assessment, teaching, infrastructure, and productivity.

The adult education field had the opportunity to review and discuss the *Connected Teaching and Personalized Learning* report through a week-long discussion on Literacy Information and Communication System (LINCS), a US Department of Education (ED) funded professional learning platform. Through a facilitated online discussion, practitioners, policymakers, and researchers identified key issues facing the field including the need to investigate the integration of technology-based strategies into instructional design and delivery and how to leverage students' widespread use of mobile technology to enhance access and learning. These topics remain critical as technology skills are increasingly required in testing, postsecondary instruction, and the workplace. Since the report's release it has been downloaded from LINCS 574 times, LINCS community of practice discussions have garnered more than 20,000 views, and it has been cited in publications such as the *Community College Review*.

While the adult education field continues to seek out new technologies to support teaching and learning across all content areas, they are also preparing to address the continued focus on preparing adults for postsecondary training and the workforce in response to the implementation of the 2014 Workforce Innovation and Opportunity Act (WIOA,

Pub. L. 113-128). As a result, the need for access to and training in the use of technology in service delivery, course content, teacher training, and program infrastructure continues to grow.

An emerging technology in education that has caught the attention of adult educators are Open Educational Resources (OER), which provide engaging, high quality instruction and learning opportunities, primarily through the use of the web-based resources. OER are licensed to allow teachers, learners, and others to re-use and disseminate content, and also to revise and develop new content that is specific to the needs of adult learners. The U.S. Office of Career, Technical, and Adult Education (OCTAE) funded the current project (that produced this report) to develop new and innovative methods to strengthen science and math instructional content and practice in adult education through the use and evaluation of OER. In this project, teachers of adult basic education students located, evaluated, used, and developed OER, and then shared those resources through an adult education-oriented group on OER Commons. Through this work and another OCTAE-funded project, the LINCS ESL Professional project focused on adult English language instruction, more than 200 OER for adult learners have been evaluated to date using the Achieve Rubrics found on OER Commons. To further support teacher development, four online LINCS courses were developed to introduce future cohorts of adult educators to OER and how to integrate the resources and open pedagogical practices into their classroom instruction. (See <http://lincs.ed.gov/>)

As adult educators continue to weave technology skills into instructional content and delivery, there remain challenges in implementation due to perceptions of learner access to devices and the Internet outside of the classroom. In a 2014 national survey conducted by Tyton Partners (Rosbash, 2014), more than 86% of adult educators and program administrators indicated that technology can “effectively support” adult education and nearly 70% of those surveyed believe that practice opportunities for students outside the classroom are some of the most important benefits of technology-enabled instructional resources. However, a majority of those educators and administrators surveyed (58%) report that students in their programs lack access to devices and the Internet outside of school and it appears this results in lower use of technology for instruction, as only 27% of respondents use mobile applications and games to support instruction. This perception of limited student access contrasts a recent survey of a non-randomized sample of adult learners in California, which found that 77% of adult learners have a computer at home and 75% own a smart phone (California Adult Education Online Application and Reporting, Outreach and Technical Assistance Network, n.d.). What teachers may be interested to learn is that students reported using these tools to search the Internet at very high rates: 64% of students use their computers or phones to do research (get information), 37% to learn in class and 31% to learn outside of class, 24% to apply for jobs, and 15% for work. Instructors and program administrators may need to revise their perceptions regarding technology as viable content delivery methods.

The need for greater technology use and instruction in adult education is profound. The results of the 2013 Organisation for Economic Co-operation and Development (OECD) Survey of Adult Skills sounded the alarm for the need to address the low literacy, numeracy, and technology skills of 36 million American adults. Of particular concern, 44% of adults below Level 1 literacy and 15% of adults at Level 1 literacy had no prior experience using computers. In response to these findings, the OECD released the *Time for the U.S. to Reskill? What the Survey of Adult Skills Says* report and OCTAE launched an engagement strategy that sought input from a wide range of stakeholders. Both the report and the engagement discussions prioritized the need to increase adults’ technology skills for high demand 21st Century jobs and provide instructional tools so teachers can help students accomplish these goals.

In 2014, only 1.7 million students were enrolled in adult basic education, English as a Second Language, and adult secondary education courses (The White House, 2014). To address the gap between the need and those currently served, OCTAE released the report *Making Skills Everyone’s Business: A Call to Transform Adult Learning in the United States* (2015) which highlights how technology can increase adults’ access to education and training in numerous ways. Online learning removes the barrier of centralized instruction for students who can now participate from anywhere at any time. Technology also makes it possible to provide more differentiated instructional delivery to accommodate varying skill levels and learning abilities. The Federal Communications Commission (FCC) is considering a national broadband plan (<http://www.broadband.gov/plan/9-adoption-and-utilization/>) to address the continued lack of high speed broadband in low income rural and inner city neighborhoods.

Later this year, the U.S. Department of Education will release the 2015 NETP. This report will focus on five key areas that have a direct impact on the implementation and sustainability of innovative digital learning: Leadership, Learning, Teaching, Assessment and Infrastructure. It

will provide examples of effective programs and initiatives nationwide that have resulted in innovative and personalized teaching and learning experiences for students in formal and informal settings such as museums and libraries—again providing models for adult education to adapt and adopt.

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