Ed Tech Developer's Guide

A primer for software developers, startups, and entrepreneurs

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Developing for Impact

Dear Innovator,

The Office of Educational Technology created this guide to assist you in gaining specialized knowledge about the education ecosystem that experienced developers have taken years to learn. Crowd-sourced from knowledgeable educators, developers, and researchers who were willing to share what they have learned, this guide is designed to help you apply technology in smart ways to solve persistent problems in education. It is our hope that this guide will answer key questions and highlight critical needs as you explore opportunities to develop digital tools and apps for learning.

The demand for high-quality educational apps is increasing as communities become more connected, devices become more affordable, and teachers and parents are looking for new ways to use technology to engage students. Yet, many existing solutions don't address the most urgent needs in education. Opportunities abound for software designers and developers to create impactful tools for teachers, school leaders, students, and their families.

Creating apps and tools for education is different from other fields. A variety of federal, state, and local policies may shape the features you choose to include, and you will need to address some unique questions along the way. The aim of this guide is to help you navigate these complexities.

The guide provides basic information about districts, schools, teachers, and students. In addition, it will help you consider questions affecting design and logistics: Do teachers have the training to use your app in the right way? How do privacy and accessibilty laws intersect with the features you want to include? Who makes the decision to purchase your tool, and how long does purchasing take? Can your app be equally effective at school and home? What features are most important to parents?

Developers and entrepreneurs who choose to apply their talents to build tools for learning have the ability to help transform education in America and exponentially increase opportunities for all students. I hope this guide will help you do that.

Looking forward to seeing your solutions!

Richard Culatta
Director, Office of Educational Technology
United States Department of Education

1 Choosing the Best Opportunity

As you begin the process of designing apps and tools for learning, focus on solving problems that have a significant impact on your intended users. Apps that simply digitize traditional practice are less meaningful than apps that support more effective approaches to teaching and learning based on sound research. This section presents ten opportunities that technology has the potential to address. This is by no means an exhaustive list, but it represents some of the most urgent needs that we hear from educators, parents, and students across the country. Each section describes the opportunity, shows why it is important, and provides some possible approaches to spark your creativity. Many solutions will address more than one of these opportunities.

Learning Powered by Technology

The U.S. Department of Education's National Education Technology Plan (NETP) presents a vision for learning powered by technology. The NETP explains how technology can support personalizing learning to address students' individual needs and interests as well as provide access to learning opportunities anywhere and throughout a person's life. The plan describes how technology-based assessments can be unobtrusively embedded into learning activities to support just-in-time assistance, measure important student competencies, and provide feedback to inform continuous improvement efforts across the entire education system. The NETP also suggests a new role for teachers as they shift to connected teaching, joining networks of individuals forming professional communities to support student learning and act on insights from data provided by technology. The NETP envisions a learning infrastructure that provides access to people and resources at all levels of the education system and a role for technology in enabling the redesign and transformation of schooling in ways that increase efficiencies, reducing the time teachers must spend on administrative activities.

Opportunity 1: Improving Mastery of Academic Skills

Perhaps the most obvious place for apps and tools to be helpful is in providing support for teaching academic concepts such as math, science, language arts, social studies, and world languages. New learning activities that help students increase academic proficiency are in high demand. In particular, teachers are seeking tools to help increase opportunities to practice skills in authentic environments and help students take more control of their learning. Each state posts its curriculum standards that show the specific skills that are taught in the state in each content area.

Why is this important? Students need to demonstrate proficiency in certain academic skills in order to move from one grade to another and to graduate from high school and then from college or other training programs. These are skills that are important for students to have to be successful in their careers or postsecondary education. Yet international tests like the Program for International Student Assessment (PISA) show that U.S. students are falling significantly behind those in other countries in mathematics, reading, and science (see *LA Times* article Are America's Students Falling Behind the World?).

What would help? Create apps to teach academic skills in more meaningful ways than traditional textbooks and lectures. Give learners an opportunity to practice in realistic settings. This might be done through interactive simulations (e.g., models of ancient cities that allow students to experience history or virtual chemistry simulations that might be unsafe to reproduce in a classroom). Think beyond delivering content—are there tools that enable students to build and create projects that encourage deeper exploration of a particular topic? Consider merging teaching and assessing to pinpoint knowledge gaps along the way to mastery through probes of understanding or by identifying

> ## Innovate, Don't Digitize
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> The value of technology for transforming learning is lost if it is only used to digitize traditional materials (e.g. scanning worksheets makes them digital, but doesn't improve the learning experience). Instead, think about innovative approaches that allow students to engage with content differently. What does technology make possible that could not be done before?

competencies through formative assessments that are seamlessly embedded in the learning materials. New forms of media such as educational games can break traditional molds, allowing students more freedom to explore, create, and collaborate, and can open the door to more immersive learning experiences. While research has been conducted to identify effective teaching methods for just about every subject, those methods don't always make it into practice in the classroom. Creating apps that put research-based methods into practice can greatly impact instruction and learning.

Opportunity 2: Developing Skills to Promote Lifelong Learning

Researchers and educators recognize that students need to develop not only academic skills, but also non-cognitive social and emotional skills and behaviors that lead to their long-term success. For example, what attitude do they have about learning? Do they feel like their abilities in a subject are fixed ("I'm just no good at math!"), or do they recognize they can grow ("I can succeed at math, but I will need to learn some new strategies in order to approach this problem set")? Non-cognitive skills such as perseverance, self-regulation, and effective strategies for approaching learning enhance student motivation and engagement, and there are many ways apps can be designed to support the development of these non-cognitive skills and behaviors, with promising results (see Readiness for College: The Role of Noncognitive Factors and Context from the University of Chicago and the Bill and Melinda Gates Foundation).

More than Working Harder

Developing grit or perseverance does not just mean working harder. Rather, students who display grit have developed confidence that they can solve a problem and have developed a toolkit of strategies to apply when faced with new challenges.

Why is this important? There are many non-cognitive skills that are critical for an individual to strive for and succeed in reaching long-term goals. Researchers have found that habits such as tenacity and perseverance can have just as strong an influence on achievement as intellectual ability. There is growing evidence that learning environments can be designed to foster development of these skills. In 2013, the White House Office of Science and Technology Policy (OSTP) and the U.S. Department of Education hosted a meeting of researchers, practitioners, and industry representatives to discuss the impact of students' beliefs about their academic abilities (see *How Can We Instill Productive Mindsets at Scale?*, a report from leading researchers in the field on the meeting's research agenda regarding instilling productive mindsets).

What would help? Identify which non-cognitive skills and behaviors you are trying to develop and build opportunities to do so into your apps. Growth mindset, for example, is more likely when students believe they can achieve and when they believe that intelligence is malleable rather than fixed (see Stanford professor Carol Dweck's work on fixed versus growth intelligence mindsets). Accordingly, an app might frame mistakes as opportunities to learn and reward students who persist through solving difficult problems. It might also

Technology Brings "Growth Mindset" to Schools

With funding from the U.S. Department of Education's Small Business Innovation Research (SBIR) program, New York City-based Mindset Works developed SchoolKit, an app designed to strengthen academic and social-emotional success. Through animations, assessments, and classroom activities, students learn a growth mindset—the understanding that ability develops with effort. Pilot research in nine middle schools found significant increases in students' growth mindset, which related to increases in learning goals, positive beliefs about effort, and positive academic habits and behaviors (such as resilient responses to failure and better learning strategies). These changes also related to increases in students' GPA. Since launching in 2012, SchoolKit has been used by tens of thousands of students around the country, including all middle schools in Washington, D.C. The app is based on Carol Dweck's research on growth mindsets.

support goal setting, allow students to choose learning activities, and encourage achievement against objective standards. To improve self-regulation, students may be asked to reflect on their effort and to consider how difficult they find the material. Apps that reward hard work and tenacity should be favored over those that reinforce simply getting the right answer in order for students to advance to a new level. Game designers are particularly adept at motivating persistence, and much can be learned from the methods they use to inspire players to persevere in the face of difficulty and frustration. Finally, behavior management is an important non-cognitive skill. Teachers, especially those new to the profession, may need help establishing a productive classroom environment and climate (see this article on Classroom Management from the American Psychological Association), and classroom management apps could reward positive behaviors, potentially decreasing unwanted behaviors.

Opportunity 3: Increasing Family Engagement

Involving parents and caregivers in the learning process is a key element to ensuring student success. It is particularly essential for students who need special assistance, such as those who struggle with learning disabilities. Often parents feel left out of the education process, especially those whose work, school, or family responsibilities make it difficult to connect with teachers and school leaders during regular school hours. The Harvard Graduate School of Education published an article on the benefits of family engagement that included a summary of research on how to most effectively engage families. Family and community engagement—for students of all ages—is a focus for the U.S. Department of Education, and its family and community website provides resources for early learning in families overall and in special populations like military and migrant families as well as homeless children.

Why is this important? Schools have a tremendous role in engaging and supporting students, and parents help in many ways, including making sure that children start on par with their peers. Providing parents with at-home activities (as PBS KIDS has done in its Parents Play & Learn app and Zero to Three has done in its Let's Play! app) to support in-class learning reinforces the idea among families that not all learning has to take place in school. Parental engagement could come from daily progress updates, easy tools to communicate with a child's teacher, and resources to connect school learning to practical home activities. Connecting parents of all backgrounds to school communities empowers them to become active, informed advocates for their children throughout their education.

> ## Tip: Many Types of Families
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> When developing your app and the communications around it, remember that families come in many different configurations, so more general terms like "parent," "caregiver," or "family member" apply to more situations than "mother" and "father."

What would help? Familiarize yourself with ways to engage families (some ideas are provided by the Response to Intervention Action Network article) and then think about how to apply those principles to engage families through technology. For instance, could your app provide information to caregivers about student progress and homework in near real time and in languages spoken at home? Can your tool be used on a smartphone or in an offline mode for homes without an Internet connection? Does it help parents stay involved in their children's school activities while

balancing work or other responsibilities? For parents whose first language is not English or who may come from cultures outside the United States, can your app better help them understand and navigate the K–12 school system, including their local school?

Opportunity 4: Planning for Future Education Opportunities

Preparing for college and navigating the application process can be challenging, and the sticker price for college can be overwhelming and misleading. For example, a more prestigious college that appears to be expensive may actually be cheaper than other options once scholarships and financial aid are factored in. Using technology to help students and their families make better decisions about their future education has great promise. Many students do not apply to college because they do not know what institutions they could qualify for or how to take advantage of financial supports that may be available to them. All students, but particularly underserved students, would benefit from tools that engage them long before their final years in high school to help plan their academic path to graduate and apply to and complete postsecondary education.

Why is this important? Research, including a recent College Board study, has shown that students who graduate with a degree, even an associate degree, far outpace their peers in income generated over a lifetime of employment. Even career and technical education programs often require a two-year degree. Yet the process of planning for, applying to, and financing college can feel daunting—especially for first-generation college students and their families.

What would help? Financial aid navigators, course planners, remote college counseling, and college-to-career maps all can help students plan for and be successful in their future education plans. Additionally, new tools and apps targeted at helping school counselors could increase both the reach and amount of support counselors can provide students (on average, half the number of counselors are available to high school students as is recommended by the American School Counselor Association). Additionally, open state and federal datasets can be used to create apps for managing college finances and to identify skills needed for different types of jobs. Imagine a "jobs available at graduation" tool that uses labor statistics about job growth. Also needed are tools that interface with college course catalogs and let students interactively plan various paths to college completion. Imagine an app that lets students identify and communicate with alumni of the institution that they are attending (or plan to attend) in fields that interest them so they can gain perspective and advice.

Opportunity 5: Designing Effective Assessments

Understanding what students know and how much they are learning is an important part of education. Traditionally teachers have made educated guesses about how much their students are learning based on classroom observation and reviewing homework. Teachers often struggle, mostly because of time, with creating assessments that truly align with the skills they want to measure. They also spend hours reviewing and grading student work that could be better spent preparing lessons and working with students.

In addition, information from formal assessments is often not available quickly enough to inform instruction. Data from high-stakes assessments, for example, may actually come after a student has moved to a new grade and new teacher. Even grading quizzes or homework takes so much time that teachers often are not able to turn around the assignments quickly enough to change their instruction for the next day. True data analysis can also be time-consuming and difficult using many current assessment practices and formats.

> ## Tip: Assessment Types
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> There are two main categories of assessments. Formative assessments are frequent and ideally embedded within a learning activity. They provide quick and continual snapshots of student progress over time. Summative assessments generally occur at the end of an instructional unit, are generally more formal, and are often used to determine a final grade or ranking. Both play key and complementary roles in understanding where students are on their learning trajectories.

Why is this important? Well-designed formative and summative assessments provide teachers and students with just-in-time feedback on progress towards mastery of content and allow educators to personalize learning pathways for their students. With feedback that is almost immediate, educators can strategically adjust instruction more quickly to meet the needs of diverse learners

What would help? Technology provides a variety of new opportunities to rethink the way we assess student learning. Tools that help teachers create and share formative assessments, automate grading, and streamline providing feedback to students allow teachers to focus more of their time on instruction. Expanding assessment item types (beyond multiple choice questions, etc.) can provide educators with a more detailed and sophisticated understanding of what their students know and can do. Simulations, heat maps, and ranking are all examples of technology-enhanced assessment item types that are beginning to be incorporated into digital assessments.

Traditionally, education has struggled to develop meaningful assessments that measure non-cognitive skills such as persistence, creativity, collaboration, and critical thinking. (For more information on these skills, see the [Partnership for 21st Century Skills Framework for Learning](#).) Consider creating tools that help develop and assess these kinds of skills.

Aligning assessments with learning goals is crucial to success. Make sure you clearly understand what you are measuring. It is crucial to measure what is important not simply what is easy to measure.

Opportunity 6: Improving Educator Professional Development

The same personalized, collaborative, anytime/anywhere learning that technology can enable for students should be available for educators and administrators. Advances in technology can make just-in-time personalized professional learning available to educators wherever they may be, putting teaching tips and access to educational experts in their hands. Technology-enabled professional learning can help educators find setting-specific answers and guidance for helping their students learn. For more on designing online communities of practice for educators, see the Department's [Designing Online Communities of Practice](#).

Why is this important? Educators must constantly learn and improve their teaching skills in order to support their students. One-size-fits-all professional development sessions cannot meet the specific needs of each teacher in a school or college. Educators need tools that help them tap into the expertise of their peers by accessing networks of reliable professional support and resource sharing. This is particularly important for new and pre-service teachers.

What would help? Tools to help connect educators to one another and to expert educational researchers are key to effective professional learning in a digital world. In addition, educators need job-embedded, differentiated, and on-demand access to content that supports their mastery of effective instruction. To be of greatest use, resources to support educators in their professional learning might include ones that:

- connect educators with each other and to educational experts
- help teachers reflect on their own practice
- provide educators support to master new strategies, techniques and tools
- are available on-demand
- differentiate for a range of levels of readiness and expertise
- curate content so teachers can find appropriate support and ideas quickly
- showcase content-specific best practices

Also consider aligning tools and resources to relevant professional standards (e.g., National Board for Professional Teaching Standards Certificate Areas).

Finally, any tools built for teacher professional development should be designed according to principles of adult learning and foster a growth mindset similar to the concepts explained above for student learning. The Connected Educators web page features several channels and tools for helping educators connect to colleagues across the country.

Opportunity 7: Improving Educator Productivity

In addition to the time spent teaching and interacting with students, educators have enormous administrative burdens throughout a school year—preparing lessons, finding teaching materials, grading, reporting, communicating with parents, and supporting school functions to name a few. When administrative tasks are streamlined, teachers and leaders can spend more time working with students and deepening their professional learning. Some ways to boost educator productivity include creating tools that help teachers personalize learning for students (adjusting instruction for students who need extra time or different learning approaches), make it easier to provide feedback to students and parents, and helping teachers create, adapt, and share lesson plans, learning resources, and assessments with other teachers.

Why is this important? Teachers are a critical factor in student success, and helping teachers reduce time spent on administrative tasks enables them to spend more valuable time with students. Teachers, especially in urban schools, are at risk of leaving the teaching profession or moving to other schools (as reported in a recent Education World article). Teachers need custom productivity tools similar to those found in other professions. With these

tools, teachers will be able to spend more of their time and effort focusing on students and their learning. To hear what teachers say about their profession and how to reform it, see [Educators Lead the Transformation of the Teaching Profession](#) from the U.S. Department of Education website.

What would help? Apps and tools to help teachers streamline workflow, personalize instruction, support needs of diverse students, create and share lessons, and communicate efficiently with parents and other stakeholders can all help productivity. To most effectively adjust instruction, teachers need to track student progress and identify areas of struggle. Student performance data are becoming increasingly available to teachers in real time, but without tools to help make sense of the data or quickly identify important trends, it can be too time consuming for teachers to find the value. Design tools that organize data visually for easier interpretation. Especially for new teachers, tools that make it easier to discover, modify, and share learning resources aligned with curricular standards would be a huge time-saver.

Tip: Onboard Quickly

When developing productivity tools, pay careful attention to how long it will take teachers to learn a new tool (onboarding). Design in such a way that time-consuming training or tutorials are not required. Support should be readily available for educators with questions when using a tool.

Opportunity 8: Making Learning Accessible to All Students

Many students have differing educational needs that must be addressed—from physical disabilities to acquiring a new language—in order to learn effectively. They may need special tools to interpret learning content (e.g., decoding mathematical notation and symbols) or support for taking notes or organizing information in structured ways. Technology can increase the ability for students with differing needs to participate in the same learning activities as their peers. App developers can address these needs in three ways. First, functionality can be added to *all* apps to make them accessible to students with diverse needs, such as the ability to increase the font size or have text read aloud. Second, apps can be created to address specific learning needs, such as providing a digital word-board to children who can't speak. Third, tools can personalize learning to adapt to a variety of learner needs, such as providing alternative explanations, examples, and visualizations to help a

Universal Design for Learning

The Center for Applied Special Technology (CAST) developed Universal Design for Learning (UDL), a framework for making curriculum inclusive of "flexible approaches that can be customized and adjusted for individual needs." The CAST guidelines encourage instructional practices and educational content that embrace the widest possible diversity of learners. The UDL approach encourages the development of tools that consider this diverse range of users in the original design rather than add-on features. To see the guidelines, refer to the CAST website.

student understand difficult concepts. The National Center for Learning Disabilities is a good place to find information about learning disabilities, and more on web accessibility can be found at the World Wide Web Consortium. Accessibility needs to be considered as a feature to be built in from the outset; as these W3C videos demonstrate, watching users with disabilities navigate learning apps and tools with assistive technologies can be illuminating.

Why is this important? Schools normally won't be able to use your app if it's not accessible to students with disabilities. The Department of Education has issued guidance describing how two civil rights laws, Section 504 of the Rehabilitation Act and the Americans with Disabilities Act, apply to technology used in schools. When you design with accessibility in mind, not only do you facilitate school district compliance with civil rights laws, but your apps will become much more beneficial to your users as well, even those who may not have specific

Tip: Useful Hashtags

Consider tapping into educators' current conversations about supporting diverse learners by searching hashtags such as #ldchat, #atchat, and #spedchat.

learning disabilities. Consider how entrance ramps to buildings (designed to provide access for people who use wheelchairs) also benefit children on bicycles or parents pushing strollers. The text description added to a website to make sure a person who is blind can use a screen reader might also improve searchability for all users of the site. Apps developed to assist in communication could be a life-changing experience for learners with autism, cerebral palsy, or Down syndrome. With appropriate technology, English learners (ELs) have the ability to access the same content as

their peers and can leverage their native language and academic skills to "transfer" to the work in English, as shown in this report produced by Cambridge University Press. Generally, content should be communicable in a variety of formats so as to increase the applicability of the tool. Specifically, this may be manifested as delivery of content in *more than one* of the following forms: text, pictures or illustrations, audio, and video (whereas any one format may be insufficient to meet an individual's special needs).

What would help? Think about the human-machine interface you are building. Are there multiple ways for users to interact with and respond within your app? Could a user control your app by voice? Will it interoperate with a screen reader? Does it take advantage of accessibility settings in device operating systems? Does your app support varying levels of complexity, interaction, and support? Making your content accessible is good. Solving fundamental access problems in communication, organization, and social interaction is better. Features that customize the delivery of learning must not clutter or confuse the delivery itself, and so developers may place such settings or controls within a separate functional area of the tool.

Using a 3D printer, students at CrossRoads Middle School in Columbia, SC, created a prosthetic hand for Alyssa, an 11-year-old girl from Charleston, SC.

Stories From the Field: Designing Ed Tech Products

Stephanie Castilla is the Technology Integration Specialist at the Highlander Institute where she works with educators on a daily basis to discover models for implementing new technologies that support teaching and learning.

"Designing ed tech products for schools is an incredibly challenging and rewarding experience. Each day brings new insights and opportunities as I work with others to define and refine problems and solutions. When teachers are your target users, it is critical to empathize with their day-to-day work life. Teachers face increasingly changing expectations. They come to new applications with varying degrees of understanding, and many times they feel forced to integrate solutions into their classrooms that they themselves did not choose. With more deadlines, standards, and requirements placed on them, it is incredibly important that the tools they use not require extensive training or follow-up and, more important, that they genuinely solve a problem experienced by the teacher and not just by administration. This level of empathy is fundamental when you design anything for day-to-day use.

Well-designed experiences have the power to make someone's day more productive while providing them with opportunities to find more enjoyment and inspiration in their work. Ultimately, the key role of a designer in the ed tech space is to work each and every day to highlight the inherent joy and satisfaction found in teaching and learning and to maximize the opportunities available to all who seek to experience it."

Opportunity 9: Closing Opportunity Gaps

An opportunity gap refers to unequal access to resources or opportunities. Rural students often have less access to resources found in urban settings such as museums, cultural centers and industry experts, for example. Job shadowing and internship opportunities may be more limited in many communities. Less wealthy communities often cannot afford to provide the well-equipped libraries, rich educational experiences, and classroom equipment and resources found in wealthier communities.

The technology gap is one form of opportunity gap. Despite the growing sense that digital tools are common in educational settings, access to them is far from equal. While some schools and students have access to top-notch resources, others, such as those in highly impoverished locations, are significantly lagging behind. Without the tools, content, and connections to high-quality learning tools and experiences, these teachers and students cannot be expected to provide and experience learning in ways equal to their peers. This opportunity inequity is addressed in greater detail in the U.S. Department of Education Office for Civil Rights' October 2014 Dear Colleague Letter, which focuses on gaps based on race, color, or national origin but could be useful in approaching any opportunity gap.

Why is this important? All students have the right to an equitable education. This right should not be affected by geographic location, family income, or any other demographic factor. Apps provide the opportunity for students to access content and expertise that may not be available within the bounds of a physical school building.

What would help? While recent years have seen an increase in the amount of open education resources (OER), many teachers lack the training or time to comb through and evaluate them. The creation of pathways for the curation of content verified for quality and standards alignment and the sharing of curated sets or playlists would alleviate unnecessary stress on teachers and increase the availability of low-cost, high-quality learning materials for all. Additionally, tools designed to help students and teachers access expertise in all areas from curricular content to improved teaching practices could help better leverage the usefulness of Internet connectivity. Finally, be mindful of equity of technical accessibility when designing products. Users on slower systems should be able to access and experience an application or service with the same ease as those using more cutting-edge technology.

Opportunity 10: Closing Achievement Gaps

Achievement gaps occur when one identifiable group of students outperforms another by a significant amount. For example, the National Assessment of Educational Progress (NAEP—the Nation's Report Card) provides data that show significant gaps in mathematics and reading ability between Hispanic and white students and between black and white students (results are on the U.S. Department of Education's NAEP website). Gaps can also exist among groups such as children who are economically disadvantaged, in foster care (as reported by the *Los Angeles Times* in Students in Foster Care Face 'Invisible Achievement Gap'), or those belonging to a historically low-performing group (see the Michigan Department of Education's African American Young Men of Promise

Initiative website). Nationwide standardized tests are not the only place where gaps are evident. State and local assessments along with results from Advanced Placement course completion and testing can also help you understand achievement gaps and areas of need. For example, computer science Advanced Placement courses lack significant participation by girls and minorities, a gap described in this 2014 *Slate* article, No Wyoming Students Took the AP Computer Science Exam Last Year.

Why is this important? Demographic factors should not systematically limit academic achievement and thereby future opportunities. All students deserve the chance to pursue college and careers in areas that interest them and should not be disadvantaged because of gender, race, economic status, or any other factor. Achievement gaps in the United States have persisted for many years and need to be closed.

What would help? Everything we have discussed to this point can make a difference: helping teachers, involving parents, strengthening non-cognitive skills, targeting academic subjects, and improving accessibility help to promote equal education opportunities for all students. Illustrating how your product helps to achieve these goals while working to close gaps in achievement makes it more compelling to educators and more likely to succeed in schools.

2 The Design Process: From Idea to Implementation

Beginning

While the steps below are presented in a suggested order, development of your product may require rearranging the order and even repeating some of the steps multiple times to refine your vision, plan, product, or research base. In general, the basic process will look something like the following:

1. Surveying the field for existing products (successful and failed) and getting to know the world and concerns of your potential end users

2. Beginning from a research base supported by the most current available information from the learning sciences

3. Iterating your product based on user feedback and experiences

4. Conducting short-cycle efficacy trials to gather data that builds a case to support your product's ability to solve the education problem or dilemma you're attacking. (Given a longer time frame and greater resources, you may be able to conduct other trials and tests subject to specific regulations.)

Survey the Field

Before you start coding a solution to a particular problem, do your homework to understand what apps and tools are already attempting to address the same issue. Even if your approach is better, you will want to be able to contrast it with the status quo.

One way to get a feeling for existing educational apps and tools is to peruse app review websites such as the Edtech Index (by EdSurge) or Graphite (by Common Sense Media). These provide a description of the tools developers have already built and show you, for example, how crowded the mathematics and language arts spaces are and how few apps and tools there are for science, social studies, and world languages.

Spend some time understanding what has already been tried, what succeeded or failed, and why (e.g., by browsing the U.S. Department of Education's repository of reviewed research, the _What Works Clearinghouse_). Choose problems that will have the greatest positive impact on the intended users.

Talk With Stakeholders

Even before designing a prototype, talk with teachers, parents, students, and educational researchers to make sure you are solving the right problem and that your tool or app will meet the needs of your intended users. Say you're creating an app to help teachers assign tailored practice in reading. Start by visiting with teachers. Help them do what they do the way they do it now (i.e., volunteer) so you can observe what classrooms are like and empathize with teachers' challenges. Talk to parents about how they support reading at home. Involve them in the process of developing a solution. With teacher and parent permission, talk to students about their experience and the kinds of features they want or need to allow your solution to become a seamless part of their learning.

Disruptive Innovation vs. Incremental Improvement

Many educational apps and tools offer marginal improvements on existing practice. This often results in a positive but limited impact. These can be called "sustaining innovations." In contrast, some educational innovations fall into the category of "disruptive innovations"—they go beyond just improving the current way learning happens and radically redefine the context, goals, and/or approach based on the foundations of learning science or other leaps of insight. According to the Clayton Christensen Institute for Disruptive Innovation, disruptive products alter processes and markets, often in unexpected ways, whereas sustaining innovations automate or simplify existing processes. There is also a third category, hybrid innovations; these are solutions that straddle sustaining and disruptive innovations and are sometimes necessary in the transition from the status quo to disruptive innovation. Blended learning may be considered a hybrid innovation (see Is K–12 Blended Learning Disruptive?). Lest you think that innovation means the end of school as we know it, read Audrey Watters' The Myth and the Millennialism of "Disruptive Innovation" for a more sober perspective.

Ed tech blogger Audrey Watters created a checklist called, What Every Techie Should Know about Education, for tech entrepreneurs to assess their understanding of a variety of topics relevant to building tools for schools. The checklist explains the work that has led to this point in the ed tech movement and provides some food for thought for aspiring entrepreneurs.

Once you reach the prototype stage, get as much feedback as possible as you move through testing your assumptions. Along the way, it is essential to continue to engage your intended users as you refine your app or tool. One approach for this is to create simple mock-ups of the tool or app that you are planning to develop, including user-case scenarios that are examples of how students and teachers might actually use the technology in a

Tip: Games for Learning

Games can engage students while teaching important concepts and skills. Games for learning work best when they don't feel like a homework assignment. If you are designing a game for learning, don't forget to build tools to help teachers and parents see what students are learning through the gameplay. A general guide is to develop a game that students want to keep playing once they leave the classroom and teachers won't ask students to put away when they enter the classroom. This means striking a careful balance between game design, learning sciences, analytics, and demonstrable efficacy.

classroom setting. With these in hand, you can conduct more formal user-concept testing, where users provide feedback in a survey or through a structured or guided interview. Once you have this feedback, you can write up the results from this research and have a brief ready to show future funders or stakeholders to demonstrate that the concept has been formally vetted by its potential users and is ready for the next step.

Many educators are looking for innovative ways to integrate useful tools into their teaching. A challenge is identifying, organizing, and, if appropriate, compensating these early evangelists. In the end, the insights they provide into what teachers want may make the difference between success and irrelevance for your tool or app.

> ## ✔ Tip: Talking to Teachers
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> Brett Kopf, cofounder of ed tech startup Remind101 and alumnus of the Imagine K12 accelerator, creates services built on three principles: talk to users, build a simple product, and solve a real problem. He provides tips on how to connect with 100+ educators and the questions to ask to refine your app in the article Confirming the Problem: Talking to Teachers from edtechhandbook.com.

Base Your Design on Learning Principles and Evidence

In developing educational tools and apps, it is important to build on the foundation laid by decades of education research. Too often apps are well coded and fully functional but are based on learning theories that researchers debunked years ago, so they underperform in their core purpose. Consider the following key concepts and resources as you create your app.

> ## ✔ Tip: How to Find Teachers for Feedback
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> In an article on the Edtech Handbook website, How to Find K-12 Teachers for Product Feedback, Mike Lee, co-founder of edshelf, gives specific tips for how to identify and engage educators to obtain that critical feedback you need when you're getting started. In his words:
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> "You may be surprised to hear that there are many enterprising educators out there. I don't mean they are profit seeking; I mean they are inventive, progressive, and oftentimes tech-savvy. Some call them edupreneurs, some call them teacherpreneurs. Whatever you call them, as a startup, you can see them as innovators or early adopters."

Learning sciences. Learning sciences are related to instructional design, cognitive science, and brain research. Learning scientists study factors that enhance or impede different kinds of learning and the best ways to engage learners for maximum impact in minimal time. These researchers have made significant progress in understanding learning in ways that are highly relevant to designing educational software. Developers who are not aware of the foundations of cognitive science, instructional design, or the learning sciences can miss out on opportunities for high-impact design and ways to systematically build in features from the collection of effectiveness data that can help them improve their product. To get an idea as to whether your product is aligned with the core tenets of learning science research listed below, try using a checklist like Kaplan's Educational Product Evaluation Checklist.

Research-based design principles. Here are some resources to get you started with lessons from research

about designs for learning. Having a researcher on your team or collaborating with a research group can help you successfully apply these principles.

- The U.S. Department of Education's Institute of Education Sciences (IES) publishes guides for educators that summarize recommendations for teaching and learning based on research results. A list of these practice guides can be found on the IES website. In addition, the Department updated its General Administrative Regulations to encourage greater use of evidence in grant programs, which this EdWeek

Words of Advice: Capturing the Attention of Influencers

Vicki Davis (@coolcatteacher) is a full-time teacher at Westwood Schools in Camille, Georgia. She is also the author of Reinventing Writing, Flattening Classrooms, Engaging Minds and the popular Cool Cat Teacher Blog.

"The best companies are those that engage in conversation with teachers. Startups that have products and services crafted and advised by real teachers will always get an in with influencers. Remember, influencers will only give your product just a few minutes of time before moving on or looking deeper.

Customer service is important. Successful startups I have had experiences with answer the emails of teachers who are starting to use their services and respond to classroom needs.

Genuine contributors to conversation are always rewarded in educational spaces. There is a massive movement of educators to connect and contribute in online spaces via Twitter chats and other places, and watching these conversations is a virtual focus group for you to glean knowledge to make your company more successful. Add your moving part to the engine of positive change rather than trying to siphon off valuable resources for a need that doesn't exist."

Stories From the Field: Getting Teacher Input

Drew Minock teaches at Eastover Elementary in Bloomfield Hills, Michigan. He is also a leader in the field of augmented reality in education.

"Last year, my colleague Brad Waid and I were looking for a digital tool to document student work. After extensive research, we finally discovered a smartphone app that let us collect and organize student work in photos, videos, or audio.

After sharing the app on social media, the app creator contacted me to thank me for sharing my experiences. I took this opportunity to offer some suggestions for improving the tool from a teacher's point of view. Since then, we have had several conversations to discuss the continued improvement of the app and have put the creators in contact with other educators for their feedback. It is exciting to know our voice and opinions as educators are valued and respected and have the potential to help students all over the world engage in deeper, more meaningful learning experiences."

article summarizes.

- Research and practical experience combine to produce an excellent set of best practices for children's app development on the Sesame Workshop website.

- Two accessible and comprehensive books regarding learning from the National Research Council are *How People Learn* and *Knowing What Students Know*, which outline the science and design of educational assessments.

- The Pittsburgh Science Learning Center has created a wiki with a set of instructional principles as well as some hypotheses that are still under study. A short article from the center published in Science (subscription required) describes how to manage the complex search space that results from varying principles related to instructional timing, techniques used, and amount of time spent learning.

- The American Psychological Association website includes an article by cognitive scientist Art Graesser outlining principles that research has shown increase student gains.

- The Hewlett Foundation has supported efforts to promote deeper learning and provides this list of resources on its website.

Learning and design frameworks. As a developer, you may find that teachers will refer to particular learning or design frameworks when describing their classroom and learning goals. Here is an introduction to some common frameworks to help you understand how educators think about instruction.

- **Bloom's Taxonomy.** Bloom's Taxonomy of educational objectives (revised in 2001) is well known for defining successively deeper levels of learning. The taxonomy suggests that students develop higher order thinking skills as they move from knowledge to application and on to evaluating and creating, using

Tip: Design Thinking

If you are an educator looking to build an app or tool, consider using Design Thinking to help unleash your creativity and zero in on effective solutions. Design Thinking is a structured process for generating and developing ideas that can help you work with others to build meaningful solutions to problems in the classroom, at school, and in the community. The design firm IDEO offers a free Design Thinking for Educators Toolkit on its website and a course on the process and methods of Design Thinking. Explore this toolkit and begin brainstorming solutions for your problem.

Using Research to Inform Design

Teachley was founded in 2012 by Kara Carpenter, Dana Pagar, and Rachael Labrecque, former researchers at Teachers College at Columbia University, who bring educational research to game design. Their company won an Apple Design Award and was featured on NBC Education Nation.

"We integrate research into each design stage, from comprehensive literature reviews to formal evaluative studies. Our designs target key strategies from cognitive research that improve math learning. For example, extensive studies show that students with math learning difficulties tend to use less sophisticated strategies than typical students, which negatively impacts future learning. Our apps promote advanced strategy acquisition through the use of carefully designed virtual manipulatives that draw from this research. Developing high-quality educational software requires that designers consider the research on children's cognitive development, pedagogy, the subtleties and complexities of the content, and technological affordances."

factual and conceptual knowledge, procedural knowledge, and metacognitive knowledge (strategies and self-knowledge). For an overview, see Vanderbilt's Center for Teaching resources on Bloom's Taxonomy.

- **Multiple Intelligences.** Howard Gardner proposed eight distinct types of intelligences or mental faculties—linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, intrapersonal, and naturalistic—and further proposed that every individual possesses a unique combination of them. Teaching, he believed, should nurture many of these intelligences. (Multiple intelligences are commonly misconceived to be modes of processing information for learning, leading to such claims as that a person with a particular intelligence should be taught primarily or exclusively through means that cater to that intelligence. This has not proven to be the case.)

- **Understanding by Design.** Understanding by Design (UbD) is a framework for curriculum design that starts with identifying important curriculum goals, such as developing enduring understandings, maps these to evidence that students can show to demonstrate skills and knowledge, and then links that evidence to learning experiences that develop the skills and knowledge. ASCD's website provides resources and publishes books and workbooks to support UbD.

Use Data to Improve Your Design

You have surveyed the field, gathered stakeholder input, applied lessons from the learning sciences, and you now have an early prototype. Next, you need to try it out, gather data systematically, and use the data to iterate on the design. Where feasible, you can multiply your efforts by doing this in a partnership with researchers and teachers (see Design Thinking as a Design Process on page 29). Whatever your approach, if you objectively examine the data, you will find that you can improve your product's positive impact faster.

Iterate Design to Create a Minimally Viable Product

User feedback is important at all stages of app and tool design. Iterative design is the process of using short feedback loops to define assumptions, create prototypes, and obtain early user feedback, first to validate the need for your app or tool (or invalidate it, saving time, money, and other resources) and later to improve its usability and impact.

Educational apps and tools have different target audiences than those for the consumer market. Whether your app or tool is for a student, teacher, district, state, or national stakeholder, be aware that each has varying needs and operates under different constraints in the highly regulated and procedure-driven education domain. Using lean startup approaches, you can obtain feedback on your

Beware of "Learning Styles"

Learning styles, the idea that there are specific sensory approaches to learning that differ among people (e.g., left-brain and right-brain learners, visual versus auditory learners) and that presentation modalities should be matched to those styles, is a popular but unproven notion. The theory of multiple intelligences is often confused with learning styles, but in a *Washington Post* article Multiple Intelligences are not Learning Styles, Howard Gardner decidedly separates the two. Learning styles have remained popular even though there is no research supporting their existence. This American Association of Psychological Science article, "Learning Styles Debunked" describes a study that reviewed all the research literature on learning styles and found no evidence that using learning styles in instruction aids learning.

project and steer key development earlier. This reduces the risk of investing time, money, talent, and passion on an app or tool that may not work in an education context. You will find elements of the lean startup approach embraced at Education Enterpreneurs events (formerly Startup Weekend Edu, see event listings at EducationEntrepreneurs.co) as well as by incubators and accelerators.

Reflections From a Developer on Creating Games for Learning

Dan Norton is the chief creative officer and a founder of Filament Games, a company that has been funded by the SBIR program at the Department of Education and Institute of Education Sciences. He has designed games about a broad range of topics, from marine turtle ecology to legal argumentation, that have won numerous industry awards and have been played millions of times in classrooms across the country.

"Who doesn't like a good game? From chess to bowling to flapping (possibly even angry) birds, games have permeated our culture. With social and mobile technology infusing every aspect of our life, even Grandma has been known to cultivate a virtual farm or crush some candy from time to time.

For people who love games, this is great news. But now that games are accepted as a mainstream medium, how can we use them in educational contexts?

Firstly, the game should be about more than just having a good time. When evaluating a game for the classroom, the gold standard to ask is: "Does mastering this game mean students will have mastered the learning objectives?"

Secondly, games can ask you to step into the role of a hero: They create identities that give purpose. Games elevate writers, scientists, thinkers, and problem solvers to champion status. Students want to know why learning material matters—and games help paint that picture! Ask yourself if the game is granting players an identity that complements or empowers the learning objectives.

Finally, games are, at their heart, simply a set of rules that players must follow. Think of these rules as a system/simulation and players as "researchers" testing the boundaries of the simulation through play. This makes games well suited to express complicated, systems-driven concepts often found in science and math. Think about the rules of the game you are evaluating and see if they represent the learning space accurately.

When educators evaluate games, they think of them as an opportunity to connect, create context, and inspire students, not to entertain or distract. When evaluating games to use in classrooms, teachers are looking not for temporary diversions, but powerful new tools they can use to enhance the entire curriculum."

The lean startup approach follows the principles of Agile software development (see agilemethodology.org). It consists of a rapid-cycle efficacy trial driven by a customer development process and is used to verify that a need exists for the product and then to incrementally advance the product from that starting point. Short iterations and fast testing of assumptions drive product development more efficiently than long development times. A shorter development time leads to the creation of a minimum viable product (MVP), a bare-bones version with limited critical features to seek customer feedback. The MVP is then continually refined by testing assumptions against customer feedback and incorporating the results in the next version.

Stories From the Field:
Design Thinking in Education with Design EDU

Alex Hernandez is a partner at the Charter School Growth Fund where he leads the fund's "Next Generation" Charter Management Organization investments

"Many of us entered the field of education to change kids' lives, and the lucky among us can name former students for whom we made a real difference. What's hard about innovation in education? Changing our teaching practices. Changing our schools. Changing our beliefs about what is possible for children. We launched Design EDU because we meet so many educators who believe that "betterness" in education is possible and crave a community to support their ideas for innovation. We help educators use design thinking to bring their ideas to life.

Design thinking is a problem-solving approach—not a silver bullet—used in many industries to come up with creative approaches and solutions to problems. In a nutshell, spend a ton of time getting to know your end users (in education, students and families), identify a problem worth solving, rapidly test potential solutions, gather feedback, and keep doubling-down on what's working.

Innovators who relentlessly focus on people's needs find themselves in unexpected places. When thinking about people's need to travel more efficiently and more quickly, Henry Ford didn't try to create a faster horse. He built something altogether new that met the need in a way that no one had anticipated. Steve Jobs made the iPod because he believed there were better ways for people to listen to music.

In education, there is a growing belief that schools can be more personalized, more creative, more challenging, more supportive...just better. We don't need more committees and strategic plans. We do need to support our most innovative educators with a community of like-minded and inspired peers, the tools to bring their ideas to life, and the "space" to prototype new ideas and see what kids do with them.

One way we support our educators is through community dinners, where teachers describe an innovation they are working on at their school and identify a challenge in that work. A group of peers uses a design thinking process to surface different ways to get "unstuck" and keep the innovation going. I love this activity because it puts teachers at the center, starts positively with an innovation already under way, and empowers the community to help one another. It turns out innovation, inspiration, and community make the business of changing lives a little easier."

Rapid Feedback Through Built-in Measures of Effectiveness

To iterate on your design, you need to collect good data to make sure your app or tool is effective. It's often best to measure knowledge and attitudes before and after your app or tool is used. The U.S. Department of Education's Expanding Evidence report details ways of documenting evidence of the effectiveness of digital learning tools. One example is built-in A/B tests (or short-cycle efficacy trials) in which one set of users tries one version of the app and another set tries another,

Design-Based Research

Design-based research is an approach that bridges theory and practice in educational research. Ideas are designed, implemented, and evaluated in iterative cycles, where new ideas are identified and evaluated with each cycle. This approach requires collaboration with educational researchers throughout the design process and can be highly beneficial for creating an effective solution.

and you compare the two groups to see which had better outcomes on a specific task. These built-in A/B tests for educational effectiveness can help optimize product impacts on behaviors internal to the product (e.g., number of items attempted or percentage correct on embedded assessments), but at some point developers need to find out whether they are also optimizing against the external measures that are valued in education (such as standardized tests, course completion and mastery of learning). Several platforms for education are testing these approaches with regional ed tech innovation hubs, as described in this _EdWeek_ article on efficacy trials for personalized learning. Short feedback cycles can help you test such questions as "What are our criteria for going on to the next level?" or "Do we need interactive or static diagrams?"

Tip: Let Students Break It

Incorporation of student feedback is imperative to the design of a new tool or app. Student input helps avoid building with inaccurate assumptions and instead uses relevant knowledge and experience to drive your designs. The quality of the feedback you gather is also critical. For feedback to be truly valuable, you need to give students the opportunity to explore whatever you've created in depth. Avoid feedback gathered from a limited experience designed to be "indicative of the larger experience," and avoid asking questions with simple yes or no answers.

Dig deeper, and let students explore. Allow students to be brutally honest about what you've developed and allow them to analyze their experience using it. Let them find loopholes and shortcuts or tell you what's fun and what is boring. Listen to their feedback as they go. If they are not engaged or satisfied when you let them loose with what you've got now, they will not be engaged or satisfied when they must use it for class later.

Demonstrate the benefits of your app or tool by showing it has an effect on an outcome that matters to schools. If you are asking a school to use your creation for a significant amount of instructional time, you will need evidence that it works before many schools will take such a risk. Demonstrating that your app or tool has an effect on student learning, engagement, struggling learners, minority subgroups, or other variables that schools are evaluated on and receive funding for will make a school much more likely to try your tool.

Some developers make the mistake of assuming that time spent using their app or tool is evidence that students are learning rather than actually measuring student learning. If finding and building in measures of learning outcomes are not prioritized early, developers can slip into poor design choices because the feedback they use to measure success isn't about learning. In contrast, well-conceived, targeted data collection strategies make it possible to

measure effects such as long-term retention and preparation for future learning.

Depending on what your app or tool does, you will need to determine the best way to measure effectiveness. If you are trying to improve learning in academic subjects, in addition to demonstrating that you are aligned with relevant college and career ready standards, the tests, quizzes, and checks for understanding you provide must be validated against the measures educators care about: their own classroom assessments as well as standardized tests. If you are looking to support non-cognitive factors such as grit, persistence, and

Students test games at White House Education Game Jam

Stories From the Field: Getting Student Feedback

Dr. Alice Wilder is an Educational Psychologist, Television Producer, Writer of Blue's Clues, Super WHY!, and co-creator of Think It Ink It Publishing. Her innovative approach to research with children is cited in Malcom Gladwell's *The Tipping Point***.**

"Using technology to learn, children can become immersed in what feels like play but is in fact a powerful and often personalized learning experience. Consider a well-designed digital story for preschoolers. A tablet can take the story beyond static images and words on a page. Text highlighting, animation, and narrative prompts help bring stories to life in ways impossible with print books.

My philosophy for developing high-quality content for children is that the only way to know what kids like, what they understand, what challenges them, and what they learn from is to ask them. This has been a fundamental part of my research process in developing Blue's Clues, Super WHY!, and now Speakaboos. We take a similar approach when considering the benefits and drawbacks of learning from technology: by asking students and teachers.

This process, known as "formative research," involves testing every piece of content many times during development. After each content assessment, formative researchers provide the creators, producers, writers, and directors with direct feedback from kids. Based on that feedback, the mission and goals of the content, the mission of the writer, and learning theory, our team improves the content. We involve our target audience in the development because ultimately the product is for them, and the insights that they give us along the way make a huge difference in the end product.

We also engage an outside evaluator to conduct summative research on our content. In each and every instance in which we have had this opportunity, we have seen great success. Talking and listening to kids who are your target audience is the best and most joyful way to make effective learning environments. When learning is comprehensible, interactive, and engaging, then kids want to learn. And they will offer amazing ideas that will enhance your lessons, offer new additional ideas, and make teaching and learning more fun."

Design Thinking as a Design Process

Stanford d.school teaches Design Thinking a Design Process. Essentially, Stanford advocates that Design Thinking is creating a more desirable future and a process to take action when faced with a difficult challenge, a creative optimism well-needed in education. Classrooms and schools across the world are facing design challenges every single day—the challenges educators are confronted with are real, complex, and varied. And as such, they require new mindsets, new tools, and new approaches. Here are steps in the Stanford d.school Design Thinking Process:

Step 1: Empathy = Really get to know your user

Use human-centered design process, which puts the user squarely at the center of the process. When designing, you start with identifying who you want to design for (your user) and really get to know them.

3 ways to get to know our user:

- Observation (what we observe them doing, in the environment we want to design for as well as in other similar and different environments, so we really get to know how they live and work, what they value, etc., and can use that to help us design solutions to problems that matter to them in ways that work for them)
- Immersion (we walk in our users' shoes, until we can experience firsthand the challenges they face that can inform our design)
- Interviews (we listen to their stories to hear how they experience the challenges and opportunities they face, we focus on feelings in addition to facts, and we listen beyond what we hear directly).

Don't make average products for average people. If your users have a name and you've walked in their shoes, you can both design for them as well as get their feedback along the way.

Step 2: Define = Define the problem your user is having that you want to solve

- We always define the problem from the users' perspective. Solve the problem they actually have, not the one you thought they have.
- Reframe. Identify the underlying cause of a problem and solve that. If you only solve for the symptoms but don't understand the true nature of the problem, you are less likely to create solutions that matter.
- Aim for the Goldilocks Zone. Not too broad. Not too narrow.

Step 3: Ideate = Open up the solution set

- Ignore feasibility at this stage. An awesome but infeasible idea at this stage may lead you to a breakthrough idea you never would have considered.
- Go for quantity. Like taking pictures, the best way to get a good idea is to generate a lot of ideas.
- Embrace radical collaboration. A wider variety of ideas is generated from diverse minds. Find colleagues in different fields, different age groups, with differing perspectives.
- Go for wild ideas. Unleash your creativity.

Step 4: Prototype & Test

- The best way to get feedback on an idea is to watch someone experience your solution. So what can you create quickly that someone else can experience…today?
- Identify an important aspect of your solution, find a way to let someone experience its essence, and observe what they do.

Step 5: Iterate

On day 1 your solution is OK at best. By the time you launch, your solution will be AMAZING **because it will really solve their problem!**

self-regulation, psychological measures of these traits are necessary. In measuring parental engagement, you will need to use before and after measures: How much were parents engaged before using your app or tool, and was your tool or app the cause of the increased engagement? You can see that collecting data to make claims about impact requires planning and persistence if the outcomes you are trying to affect are not immediate.

Evaluate Impact

Rigorous evaluation takes time and careful thought and often needs to be conducted by a third party to ensure credibility.

To meet the highest standards, researchers will want to identify a comparison group that is not using your product but is similar in every way to help them estimate, and isolate, the effect of the use of your app or tool from other factors that may also influence the outcome of interest. For example, when researchers ask, "What was the impact of a tool on a particular outcome?" what they really mean is, "How did students do after participating in learning with the tool relative to how they would have done had they not participated?" Because researchers cannot observe how students would have done without the program, they select a set of similar control schools and students to use as a proxy. The idea is that if the control schools match the tool-using schools (aka, the treatment schools) closely, and if a difference is found in outcomes between tool-using and control schools, then that difference can be attributed to the tool and not some other factor such as school wealth or demographic disparities. In most cases, the more similar the treatment and control schools are, the stronger the case that the tool or app made the crucial difference.

Random assignment to create the comparison groups is the preferred approach but is not always feasible, so other matching techniques are often used. It is important to understand and acknowledge their limitations when making claims about the impact or effectiveness of your app or tool.

Teacher provides feedback to an entrepreneur at an ed tech summit in Baltimore

Gauge carefully how much and when to invest or when to partner with an organization to evaluate impact. For example, if you expect that students will use your app or tool on their own time, on the bus, at home, and it's free, evaluation could be considered low stakes/low risk. You should still collect data on how it is used but will not need to make an airtight case for its educational impact. If you expect that your solution will be adopted in the classroom as a regular practice, however, the burden of providing evidence of positive effects is substantially higher, and you will need to anticipate a substantial investment in demonstrating effectiveness.

In the latter case, you are entering a complex school ecosystem with a host of conditions and practices that your app or tool may be disrupting. These factors can include classroom cultures that teachers have established, the

teacher's role as an information provider and assessor, and norms for technology use. If you are trying to alter standard education practice, you may find that your solution morphs when implemented in the current system because of the momentum of existing practice pushing against the changes you envision.

Developing technology innovations using effectiveness research studies is often very challenging for developers because the studies generally take a long time to complete. By the time a large randomized controlled trial (RCT) is complete and reported, the technology is likely to have been updated multiples times. To move to the market more quickly, short-cycle efficacy trials can provide a research feedback loop with minimal development delays.

It may take some give and take for teachers and school officials to figure out how to adapt your app or tool to their specific needs and conditions. If you're interested in educational theories about how teachers adopt technology, look into this explanation of TPACK (technological pedagogical content knowledge) or SAMR (substitution, augmentation, modification, and redefinition), which help teachers think about their levels of technology adoption.

Once you have a successful instance of seamless adoption and demonstrated impact, convincing users becomes much easier.

Ensuring Privacy and Protecting Student Data

While this guide will introduce the Family Educational Rights and Privacy Act (FERPA), and other federal laws, keep in mind that FERPA is a floor for privacy protection, and many states have enacted more restrictive student privacy rules. It is best to assume that the student information you collect in your app is statutorily confidential, unless it is de-identified, and to build privacy and data security features into your app. The last thing any developer wants is for your privacy practices to spark a controversy in school districts that use your product.

Be Transparent

As a start, you should minimize the data your product collects by asking which data points are absolutely necessary. For those that make the cut, prepare a rationale for the inclusion of each data point so that you can make your case to educators and families. Rather than waiting for questions or potential criticism of your data collection, be transparent with schools and families about what you are doing with student data, why the data have educational value, and what safeguards are in place to protect the data. You can post this information on your website, as well as write your terms of service agreements in plain language. Your public information should outline how your product aligns with state and local privacy statutes, as well as the federal statutes outlined below. In preparing your terms of service, you might consider the Model Terms of Service guidance issued by the U.S. Department of Education.

Student Data and Privacy

While not every app or tool aimed at schools is intended for student use, many learning apps do rely on the use of student data in one form or another. Ed tech developers must be aware of how data privacy, confidentiality, and security practices affect students; privacy laws and best practices exist to keep children safe while using

innovative technology services. It is critical that software developers understand these laws and practices and implement appropriate safeguards for student data. Not considering them is irresponsible and in some cases illegal.

FERPA (the Family Educational Rights and Privacy Act) gives parents the right to access and seek to amend their children's education records as well as protects personally identifiable information in education records. These parental rights transfer to the student when the student turns 18 years old or attends a postsecondary institution at any age. (Students to whom FERPA rights have transferred are termed "eligible students.") FERPA generally requires that prior written consent of parents or eligible students be obtained before schools can share personally identifiable information from a student's education records unless an exception applies.

If your product is being used in a school, you should review PTAC's [Protecting Student Privacy While Using Online Educational Services: Requirements and Best Practices](#) for guidance regarding legal requirements and best practices.

It is important to note that schools and teachers that use apps with a "click wrap" terms of service agreement must still comply with FERPA. Schools that use apps will almost always be contracting with app developers using the school official exception, meaning that the developer can only use the student education records in accord with their arrangement with the school – and the school has to have a "legitimate educational interest" in entering into the arrangement. Marketing unrelated products to students and parents is not a legitimate educational interest.

App developers should explore whether using de-identified data for research and product development is a possibility, as de-identified data is not covered by FERPA. Keep in mind, however, that it can be challenging to truly de-identify student data, and de-identification typically will require removing the school code, as well as name, date of birth, and other more obvious identifiers. More details can be found at the [U.S. Department of Education FERPA website](#).

COPPA (the Children's Online Privacy Protection Act) governs online collection of personal information from children under age 13. For example, before an app can collect any information from students under 13, "verifiable parental consent" is required. The Federal Trade Commission, which enforces COPPA, has said that school officials can act in the capacity of a parent to provide consent to sign students up for online educational programs at school. The general guidance is that software companies are allowed to track students within their program, but COPPA prevents them from tracking those students across the Internet. More details can be found on the FTC's [COPPA compliance FAQs.](#)

CIPA (the Children's Internet Protection Act) imposes several requirements on schools or libraries that receive E-rate discounts for Internet access. Schools and libraries must certify that they have an Internet safety policy that includes technology protection measures. These protection measures must

> ## Tip: Privacy Support
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> The U.S. Department of Education has established a [Privacy Technical Assistance Center](#) (PTAC) website as a one-stop resource for education stakeholders to learn about data privacy, confidentiality, and security practices related to student-level longitudinal data systems and other uses of student data. PTAC provides information and up-to-date guidance on privacy, confidentiality, and security practices through a variety of resources. Do not hesitate to contact PTAC.

block or filter Internet access to pictures that are obscene, pornographic, or harmful to minors, and schools must also monitor the online activities of minors.

Because most schools receive E-rate funds, they are required to educate their students about appropriate online behavior, including on social networking websites and in chat rooms, and to build cyberbullying awareness. Particularly if your app involves networking among students, keep that in mind and consider ways that you can help schools comply. More details caon be found on the Federal Communications Commission's CIPA FAQs.

PPRA (the Protection of Pupil Rights Amendment) is intended to protect the rights of parents and students including, but not limited to, requiring that public elementary and secondary schools make instructional materials available for parents' inspection if those materials will be used in connection with a survey, analysis, or evaluation funded by the U.S. Department of Education and in which their children will participate. The PPRA requires that public elementary and secondary schools obtain parental consent before minor students participate in certain types of Department-funded surveys, analyses, or evaluations. The PPRA also requires that public elementary and secondary schools provide parents, upon request, a right to review any survey created by a third party before the survey is administered or distributed by a school to a student and generally requires them to provide notice to parents along with the opportunity to opt their children out of activities involving the collection, disclosure, or use of personal information collected from students for the purpose of marketing or for selling that information (or otherwise providing that information to others for that purpose). More details can be found at the Department's PPRA website.

Individuals With Disabilities Education Act (IDEA) also provides confidentiality protections, and will often additionally protect information for students with disabilities.

Special Considerations for Research

In some cases, you may need to collect personally identifiable information (PII) in order to conduct research on your app or service. If your research involves human subjects (students, teachers, parents, or administrators, etc.), you should acquaint yourself with the rules for consent. The Department's regulations can be found at 34 CFR Part 97.

For more guidance on using human subjects in research, see Protection of Human Subjects in Research from the U.S. Department of Education.

3
Networking and Funding

Even the best ideas benefit from the vetting and support of experienced people who can contribute advice, expertise, and early financial resources until you achieve self-sufficiency. This section describes how to find people who can help you shape your idea, reach your target audience, and create a sustainable model to support the work you want to accomplish.

Finding Like-Minded People

Community is essential to ed tech entrepreneurs for idea sharing, funding opportunities, and scaling. Several organizations are creating thriving communities committed to harnessing the power of the technology to transform the way students and lifelong learners achieve their educational goals. You can find them via meetups, hackathons, startup weekends, social networks, and (un)conferences.

Education hackathons are education-related developer events often organized by co-working spaces or incubators and accelerators. Sometimes universities will also sponsor hackathons through their business or education programs. If you can't find an education hackathon in your region, consider hosting your own following the guidelines at edtechhandbook.com.

Education Entrepreneurs Startup Weekends are 54-hour events that bring together educators, entrepreneurs, developers, and designers to design and validate an ed tech solution over the course of a weekend. These events are a great way to determine if your idea has enough validity for you to continue building. If you can't find a Startup Weekend Education near you, consider organizing your own using guidelines from EducationEntrepreneurs.co.

Ed tech meetups, like other meetups, are open meetings with a social impact component followed by speakers, panelists, etc., who are drawn from the local community. Held as often as weekly in some cities, ed tech meetups can be informal opportunities for educators and entrepreneurs to explore topics at the intersection of education and technology, to learn about the technologies supporting teachers, and to hear from teachers about problems in education. You can find ed tech meetups in your area by searching meetup.com for for keywords like "ed

EdCamp co-founder Kristen Swanson joins Secretary Arne Duncan at an EdCamp at the U.S. Department of Education

tech" or "education technology." If you're considering organizing your own meetup, you may find the article "[Bringing the Baltimore Charm to Your Edtech Meetup](#)" helpful.

EdCamps are designed and driven by educator participants. Collectively the group begins the day by determining what they want to discuss and learn from each other and then organizing sessions throughout the day on these topics. EdCamps can be great opportunities to learn from educators where they struggle, where their pain points are, and what tools they might need. It is important to respect the culture of EdCamps; these events are not sales opportunities but rather learning opportunities. The EdCamp Foundation offers [suggestions](#) for organizing your own EdCamp.

Unconferences, like EdCamps, are participant-driven professional learning events that reject the format of traditional conference and professional development experiences. In typical unconferences, the participants set the agenda and topics, and the event includes open time for discussions and collaboration.

Other ways to connect and keep up with ed tech, such as at traditional conferences and on social networks, are listed later in this guide.

Ed Tech Incubators and Accelerators

Incubators and accelerators help speed up the process of creating and distributing a tool or service. Both provide mentorship and a community workspace for participants. Some support recruiting and developing strategic partnerships.. Both typically offer participants reduced-cost services (e.g., cloud web services, legal, marketing, graphic design, etc.) through partner companies. However there are also some key differences between the two.

Accelerators provide seed funding and media exposure, often to more experienced entrepreneurs. Accelerators prepare participants to for a major milestone—usually the ability to attract a large investment round. Accelerators take small amounts of equity in return for funding and mentorship. The goal is to scale fast and rapidly increase the value of your tool or product over a course of three- to four-months,.

Incubators, on the other hand, bring in an external management team to foster an idea that was developed internally. The goal of incubators is to help build a company. Incubators take little or no equity in the company, which is an important consideration if your goal is to retain control of your business or prepare to participate in an accelerator program. The table that follows shows the general distinctions between incubators and accelerators.

Education-focused incubators and accelerators have sprung up in recent years. EdSurge maintains a [list of education incubators and accelerators in North America](#). Developers with a novel idea for solving an education problem are often drawn to an incubator or accelerator for quick capital, access to schools, access to investors, software development expertise, or experience in the complex world of school distribution. It can be difficult to be accepted into an incubator, and being part of one does not guarantee success. Consider your needs and speak with startup founders who exited an incubator about their experiences before you join.

Comparison of Incubators and Accelerators		
	Incubators	**Accelerators**
Cost of participation	Models vary from no cost to to paid services (frequently in the ~$3,000 range) to services in exchange for equity.	Commonly offer a suite of services in exchange for equity (usually 6–8%).
Program funding	Likely to be not-for-profit efforts, often funded by government, philanthropic foundations, or other not-for-profit organizations. However, can also be for-profit, operated by investors or other businesses.	Likely to be for-profit efforts operating on models similar to early-stage venture capital firms. Most have their own investors. Inquire about investor relationships or obligations inherited by participating in the program.
Length of program	Likely to be longer term (often a year or more) or offer open-ended participation based on milestone achievement.	Programs typically last about 3 months.
Common traits	Tend to attract participants that have products that are further along in the development process. Participation on site may not be required.	Generally perceived as intensive programs, and many participants are in the very early stage of product development. Participants are typically required to be present on site.
Seed funding	Generally not offered.	Typically provide $15–$25k seed funding, and may guarantee additional funding upon completion.
When should you participate?	If you have schedule constraints that prevent the commitment an accelerator requires, if you expect your company to grow organically and don't need outside investment, or if your idea is not sufficiently developed to be accepted by an accelerator, you may consider participating in an incubator.	If you expect your company to grow rapidly and reach high scale in a short time—perhaps before you've generated significant revenue—and/or you will outside investor capital to launch, you may consider participating in an accelerator over an incubators.

Adapted from Heather Gilchrist of Socratic Labs. Used with permission.

Other Funding Opportunities

Once your app or tool is beyond a minimally viable product with a small set of users, you may need additional funding to continue to develop it and scale it to serve more users.

Crowdfunding is a way to raise money by asking for small contributions from many supporters, often those in your personal network. In return, project supporters typically receive early versions of your tool or other related items. A modest donation may result in a free T-shirt, whereas a more substantial donation may result in a free subscription to your app or service. Crowdfunding can also be an effective way to reach out to potential beta testers. There are a

Tip: Crowdfunding

A few education developers have been down the crowdfunding path and share the good, the bad, and the ugly of their experiences on the *Education Times* website. Read about the experiences of BrightLoop and Odyssey Initiative.

variety of crowdfunding platforms to choose from, including CrowdTilt, IndieGoGo, and Kickstarter. Each has its own style of campaigns and backers, so you'll have to do some homework to select the one that best fits you and your tool. Keep in mind that the models are often all or nothing, so if you don't meet your funding goal, you might walk away empty-handed. You can also check out CrowdsUnite, a review site for crowdfunding platforms.

Grants and innovation funds can also be resources for development or testing in the field. Although the application process is more involved than crowdfunding, grants can offer a chance to work more formally with new partners (such as research institutions or school districts). Here are a few examples of government innovation programs and foundations:

- The Small Business Innovation Research (SBIR) program is a federal initiative that "enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization" (as described on the SBIR website). Through SBIR, 11 federal agencies, including the Department of Education, fund R&D projects that stimulate technological innovation, address national needs, and strengthen small businesses. The Department's SBIR program provides $7.5 million a year to develop and evaluate commercially viable education technology products to improve student learning and teacher instruction. Examples of companies funded by SBIR include Filament Games, Sokikom, Teachley, Triad Interactive Media, Fluidity Software, and Zaption, to name a few. See this Education Week article and the ED SBIR website for a deeper look. You can also explore some of the many games SBIR has funded in this playlist.

- Challenge.gov is a government portal that shows opportunities from across government agencies where new solutions for education are needed. Challenge.gov links innovators with funding opportunities to promote innovation as well as increased capital formation in the field.

- The U.S. Department of Education's Investing in Innovation (i3) program has funded 92 projects seeking to provide innovative solutions to common education challenges. Funding for innovative uses of technology can also come from the federal Race to the Top District Competitions.

- The U.S. Department of Education's Institute of Education Sciences research grants provide awards for $1.5 million or more for technology development, and up to $3 million in efficacy evaluations of education technology across many content areas. Awardees are typically academic researchers, but startup developers are eligible to apply and have won awards in recent years. You may consider partnering with an academic researcher to strengthen your application.

- The Foundation Center's Foundation Directory can be a source for connecting your product and team to organizations with a similar interest in solving the education problems you're solving.

- Local foundations may invest in underserved schools in their area with ed tech solutions that target critical needs that align with the foundations' mission. This can provide more mature products with important exposure in schools.

Angel investors are good to connect with when you want to raise private capital to build your startup (angel investors can include friends and family). AngelList offers the most comprehensive platform for researching and connecting with angel investors. There are also angel networks that focus on social impact investing, such as Investors' Circle. In general, early angels will come from your personal network.

Venture capitalists and institutional investors have been eager to join the ed tech trend in the past few years. NewSchools Venture Fund compiled information on "Who's Funding K-12 EdTech?" and posted the article "A Closer Look at K12 Ed Tech Venture Funding in 2013" detailing recent ed tech funding. In addition, EdSurge maintains a list of investors interested in ed tech.

While you should raise as much money as your company needs to achieve major proof-points/milestones, overfunding a company too soon can also have its own risks. More investment money leads to more investment terms and complexities for founders, issues in receiving future funding, and a risk of misappropriating funding early on. The rules around a venture capital (VC) investment are usually a little more complex, and large portions of equity and control can be taken by the firm. Consider lower risk sources of funding such as angel investments, crowdfunding, and the lowest possible, private and public sector seed grants.

Moving a product to scale once it has shown traction in the marketplace requires significant capital to keep the business growing, to strengthen marketing and outreach plans, and to further strengthen the technology so that it is sufficiently robust to be used by the masses. During this phase, many developers seek venture capital or angel

Words of Advice

Matt Greenfield is a managing partner at Rethink Education, which seeks to invest in progressive growth-stage companies that are at the forefront of the education technology industry and have the ability to make positive impacts in communities.

"Your goal should not be to start a company: Your goal should be to solve a problem.

Find a problem about which you are passionate. Ask yourself: Does the world need your company? Does the world need your software? Do I really believe deeply in meeting this need? What feels urgent? Who am I really selling this to?

Do your research: Is someone else already in that space? What do I really understand about education—how do teachers work, how do schools spend money, and what is really effective? Can I imagine—clearly see—a transformation or a fundamental shift in this space?

Question your assumptions. Do you need to start a company, or should you work for one that's already out there? Or maybe join, or start, a nonprofit.

If you choose the startup route, be prepared for the long haul and possible disappointment. Be a zealot on a crusade. That is the only way to survive the journey."

investments in exchange for a portion of the rights to their technology to cover the costs associated with further developing it to fit the needs of individual schools and to handle larger volumes of users and data.

While there are many resources for learning how to move your idea from inception to distribution, two places to start are the set of insider tips on the edtechhandbook.com website by experienced entrepreneurs Michael Staton and Mick Hewitt and this EdSurge article from the founders of Wikispaces giving their perspective on the fundamental principles that are needed to succeed in educational technology.

4 Inside a Typical School District

School districts (also known as local education agencies, or LEAs, which oversee schools within a defined region), state departments of education (state education agencies, SEAs), and the U.S. Department of Education also have distinct roles and responsibilities in K–12 education. This section lays out a few basics on their respective roles, school funding, staff, and infrastructure elements as they concern ed tech. For a more comprehensive look at the public school ecosystem, see A Public Education Primer: Basic (and Sometimes Surprising) Facts about the U.S. Education System by the Center for Education Policy.

Federal, State, and District Responsibilities

The federal government plays a role in K–12 education through the enforcement of civil rights protections in the Constitution and federal laws prohibiting discrimination against and ensuring equal educational opportunities for all students regardless of race, color, national origin, sex, or disability. In terms of influence on a school, outside of civil rights enforcement, the federal level has the most indirect role, primarily leveraging a series of grant programs to encourage states and districts to raise academic standards and provide equitable opportunities for all students. For example, states and districts that receive specific federal funding must provide additional educational services to low-achieving children in low-income schools. States receiving federal funding must ensure that teachers are highly qualified, set academic content and student achievement standards for what students should know and be able to do at each grade, and must test nearly all students in grades 3–8 and once in high school.

States and school districts determine how to implement federal requirements through decisions at state departments of education or school districts. Generally, states set requirements for compulsory schooling, attendance, and graduation policies, and these vary by state. Whether decisions are made at the state or district level also varies by state. So-called "local control states"—defined by EdGlossary.org—delegate most decision making to LEAs. The states set standards for what students must know and be able to do; some states also create a curriculum corresponding to the standards, whereas others leave that task to districts. Some states approve textbooks; in others, districts make their own textbook decisions. States have the authority to hold schools and districts accountable for students' academic progress. Generally, states have the responsibility to set teacher preparation and certification requirements, and districts handle staff hiring and compensation.

District Funding Sources and Budgets

District funding also varies by state. To understand how a school could purchase an app or tool—for example, as part of a technology upgrade or a program to serve a special student population—it's important to understand how districts operate and how they are funded.

K–12 education funding, on average, comes from state funds (47%), local community funds (43%), federal funds (9%), and private funds (less than 1%, competitive grants and donations). State and local funding for education is usually raised through taxes and bonds. However, some districts have taxing authority, some have bonding authority, and some have neither. LEAs administer these funds for local public schools within their boundaries.

School budgets are influenced by the source of funds (federal, state, or local), and the exact details of school funding and budgets vary across the approximately 14,000 school districts in the United States (the most current statistics on district numbers can be found on the National Center for Education Statistics website). Charter schools, an alternative type of public school that is often subject to fewer state and local requirements, are often funded via the same mechanisms as other public schools, receiving funding based on the number and/or type of students they serve. Just the basics are sketched here; for more information on school budgets and funding, see this 2012 PDF report, School Budgets 101, from the American Association of School Administrators as well as Money Matters: A Primer on K–12 School Funding from the Center for Public Education. For state-by-state public school financing, you'll have to search for information for each state. For example, in 2013 California enacted sweeping changes to K–12 funding called the Local Control Funding Formula, which necessitated changes in the way schools think about budgets based on student needs. The website for the California-based organization EdSource describes the changes in their article, "A New K-12 Funding System Demands New Thinking in Building Local Budgets,"

Facts About School Budgets

- Where does the money go? The Center for Public Education (in Money Matters: A Primer on K–12 School Funding) states that, in general, money goes to instruction (66%), operations (17.8%), administration (11%), and student support services (5.2%). Most of instruction funding goes to staffing, leaving 9% for supplies and services.

- How are long-term purchases handled? Public school districts face pressure to use all their funding in a given fiscal year and generally cannot save funds over time as a way to afford larger one-time expenses. Funds left over can make a school's budget seem excessive when each year's budget is supposed to pay expenses for only one year.

- What is the budget timeline? Many LEAs operate on a budget period of July 1–June 30, so a typical budget process would begin in the fall to evaluate existing programs and set program priorities for the next year. By midwinter, LEAs would integrate the estimated costs of new initiatives, anticipated savings, and any cost adjustments into a preliminary budget. Meanwhile, the state budget is submitted, and districts can make their projections. In the spring, district budgets are adopted only after final review and public hearings, while concurrently the state budget is signed into law and funds become available to districts for the upcoming school year. District budget decisions are typically proposed by district administrators and approved by the school boards. Many larger districts must first present to a school board committee before presenting to the full board. Some district decisions must be approved by an additional level of government, such as city councils, which can extend timelines.

Federal Funding - *Elementary and Secondary Education Act*

The primary source of federal K–12 support began in 1965 with the enactment of the *Elementary and Secondary Education Act (ESEA)*. (In 2002, ESEA was reauthorized by the *No Child Left Behind Act, NCLB)*. ESEA provides funding, primarily to state and local educational agencies, through a wide variety of programs to support services for disadvantaged students, e.g., low- income students, English learners, or migrant students, with the general goal of improving academic achievement for all students. Although federal funding is a small overall percentage, it represents important monies for LEAs, and federal funding—for special purposes and populations—cannot be repurposed to cover other expenses.

Competitive Funding: Innovation Funds

Multiple initiatives at the federal, state, and private foundation levels seek to support innovative education reform. These programs typically award short-term funding (12–60 months) to organizations that qualify for it.

EXAMPLES OF FEDERAL INNOVATION FUNDS

- Race to the Top is a U.S. Department of Education competitive grant program designed to encourage and reward states and districts creating the conditions for education innovation and reform.

- The Investing in Innovation (i3) Program at the U.S. Department of Education has funded 92 projects seeking to provide innovative solutions to common education challenges.

EXAMPLES OF STATE INNOVATION FUNDS

- The New York School Innovation Fund awards grants to partnerships committed to the rigorous work required to redesign and turn schools around into high-performing, high-quality organizations.

- Wyoming Trust Fund For Innovative Education Grants supports innovative educational ideas leading to the improvement of public education.

- The Rhode Island Model School Grant (supported by Race to the Top, 2012) was a competitive grant process that awarded $470,000 to an elementary school in Rhode Island with a powerful blended learning vision and strong implementation partnerships.

- The Maryland Digital Learning Innovation Fund is designed to help local school systems maximize new and emerging technologies to improve the teaching and learning, as well as to better prepare all students for the careers of the future. These grants have awarded a total of $3 to $5 million each year.

Key People

Schools are complex organizations with long-standing practices. Understanding how people are organized will help you make sure you are engaging the right decision makers. Generally, districts (and larger schools) will have several departments focused on special areas, such as curriculum and instruction, English learners, special education, and IT/technology. The director of curriculum, working under the direction of and in collaboration with the superintendent and the school board, determines the academic strategy and implements the goals for the district, including digital learning approaches. Each department can have a say in how technology is used to meet its goals and can influence how funding is allocated to apps and tools. If the school receives federal Title I funding for disadvantaged students, it may have a Title I director who oversees the turnaround approach for the school, and most schools also have a director of special education who manages the federal funds for students with disabilities.

Schools rarely make funding decisions; districts allocate resources across schools to ensure uniformity of curriculum and instruction. Other times, schools are granted greater fiscal autonomy as they meet various performance thresholds. However, movements are under way to give principals greater authority to spend resources to meet specific needs, particularly for schools identified as persistently low performing.

Because of smaller size, greater flexibility, and site-based management, charter schools represent a more local staff-based approach to fiscal decision making than district schools. Generally, charter teachers have more input in allocating instructional resources. In some cases, individual teachers also have small budgets to purchase materials to meet the needs of specific students.

Regardless of whether a school is a traditional public or a charter school, the general theme for all school-based educators—from principal to kindergarten teacher—is *busy*! Educators have many demands placed on them and limited time to juggle a host of responsibilities. Most likely, the teacher you're talking to or the principal you're calling is forgoing lunch or a trip to the bathroom to have a conversation with you. Keep your interactions short and focused, and recognize how valuable their time is.

School leaders. Traditionally, the term "school leaders" refers to the principal and assistant principals. The principal has the primary responsibility for shaping a vision for academic success and managing the school. (For research on the role of principals, see the Wallace Foundation report: The School Principal as Leader.) Assistant principals may have a variety of roles from handling discipline to managing relationships with parents, to overseeing teacher performance. However, there are many school leaders in addition to principals and their assistants. College and career counselors, reading specialists, lead teachers, instructional coaches, etc., are also school leaders. In addition, many times technology coaches and teachers most comfortable using technology are involved in making decisions about what tools and apps will be used in a school. When working

Teachers as Purchasers

Grassroots efforts are under way to empower teachers as fiscal decision makers. This movement is in its infancy, but as innovative and relatively inexpensive apps and tools become available, many educators hope the tension between bureaucratic procurement policies and teacher demands will be addressed. Some notable teacher purchasing projects are the experimental Teacher Wallets project and a platform called Donors Choose on which teachers can post technology and other requests for funding through crowdsourced donations.

with schools, it is helpful to identify which school leader is responsible for the problem your app or tool is intended to solve.

School leaders often spend much of their day in classrooms observing teachers and providing instructional coaching. If your app or tool is intended for use by school leaders, remember that their jobs are becoming increasingly mobile and require access to data and information in any location in the building.

Teachers and instructional specialists. Educators who work directly with students have advanced degrees or certifications in their specialty area and teach multiple subjects for elementary and possibly fewer subjects in middle and high school. In elementary school, teachers often collaborate at a grade level, whereas in later grades, the collaboration may be more department based. Increasingly, school librarians and media specialists are serving as points of contact for technology acquisition, evaluation, and implementation. Even in schools where this is not their formal role, new technologies can eventually fall under their purview. When approaching schools and districts, make sure your messaging speaks to and acknowledges all parties. For more information about the daily lives of teachers, check out these websites from the Carnegie Foundation, Inside Teaching and the Gallery of Teaching and Learning.)

Not all teachers are early adopters of new technology, but those who are can be helpful to someone developing a new app or tool for classroom use. Sometimes early adopters can be found on teaching- or technology-oriented committees, and they are also often the experts other teachers go to for technology-related questions. If you can get an early adopter excited about your app or tool, that educator has the potential to get other teachers in his or her larger network as well as the school administration excited about it as well.

Home and family. Although some apps may be intended for use only in a formal school environment, many are targeted to parents for their children to use outside school. Traditional uses like test prep, tutoring, and homework help remain attractive to families, and more families are also using apps for mobile devices like math apps, e-books, and learning games, especially those apps that are engaging and demonstrate that they can help children learn. Many companies that provide schools with learning technologies also include capabilities for use at home or Internet-enabled locations such as libraries (keeping in mind that not all families have access to high-speed Internet at home). There are also good side-by-side apps designed for family members to use with their children. Even if your app is designed for use at school, it is important to consider ways to share student progress with adults in the home. For an example, see the case study School Districts Use Mobile Apps to Engage Parents that describes how a district built a mobile app to push student information to families' phones.

Maker Movement

Some parents are eager to involve their children in hands-on media or maker projects. Making has become the umbrella term for the events, local community spaces, and online communities dedicated to the design and manufacturing of objects and installations using such tools as 3-D printing and metal- and woodworking. Parents may have been to a regional MakerFaire where makers gather to showcase their creations. An example of an organization leading this charge is the Maker Education Initiative.

The maker movement is supported by technology in many ways including engineering, robotics, and fab labs. Sites like DIY.org and Makezine.com are promoting coding, making, design, and media creation. Simple kits and applications are becoming more accessible for students of all ages, and developers should be aware that a growing number of parents are excited about doing these activities at home and supporting them in school.

Students. While students are in a group of their own and may not typically purchase ed tech apps and tools with their own money, their influence on the ed tech market should not be discounted as they are the users most developers have in mind. Many students take personal devices to and from school (for example, *THE Journal* reports high use of smartphone use in Advanced Placement and writing courses), and some districts are adopting BYOD (bring your own device) policies, as reported in this 2013 *Wired* article, The Future of Education: BYOD in the Classroom. Some students, particularly guided by a family member and/or teacher, are also looking for mobile apps to learn with on their personal devices or websites to help with formal coursework or informal learning. Remember that, while a teacher or family member may judge an app solely on its academic credibility, students must have a seamless, effective, and engaging experience if they are actually going to use the app to its full potential.

Technology Infrastructure

Many schools are now gaining access to and building good technology infrastructures and the technical support to keep them running smoothly. Still, you may encounter schools that have a patchwork solution run by part-time personnel who wear multiple hats. It is a challenging environment for introducing new ideas and approaches; developers who are used to targeting the latest smartphones and who assume continuous, ubiquitous connectivity sometimes are surprised to see some schools' technology limitations. Conducting research up front can help you design a solution that is robust enough to work in multiple environments and save effort you might put into a solution that requires infrastructure that not all schools have. Build toward access by users with all sorts of capabilities and away from the assumption that they will have fast connectivity and devices.

Schools use a variety of devices (such as tablets and laptops) to connect to the Internet, and some also have a BYOD policy. This means that apps and tools must run on many platforms, including older operating system versions. When introducing your product to potential users, include documentation of all the possible interoperability (sending and receiving data) you bring to the table, system requirements, external sites and platforms schools will need to whitelist, and your ability to personalize a product to meet specific needs.

President Obama set the goal for 99% of students to have access to broadband Internet and devices by 2018 through the ConnectED Initiative. This presents a great opportunity for ed tech developers to help schools gain

Digital Citizenship

Our lives have transitioned into an immensely digital world of learning where one-to-one (1:1) initiatives and bring your own device (BYOD) policies are growing rapidly. Consequently, there is an increasing need to spread the conversation about the responsibility that students, teachers, parents and technology leaders have in the digital space. So what exactly is *digital citizenship*? Digital citizenship establishes a set of norms and practices regarding appropriate and responsible technology use. Digital citizenship requires a whole-community approach to thinking critically, behaving safely, and participating responsibly online. Bringing national attention to this topic, organizations such as Common Sense Media, a media and technology awareness organization, in conjunction with Connected Educators hosts "Digital Citizenship Week" to empower students, engage families, and connect teachers. Leading the charge in the classroom, Common Sense Media is quickly spreading its K-12 Digital Literacy & Citizenship Curriculum, which addresses digital literacy and citizenship topics in an age-appropriate way. Common Sense Media simplifies the user experience by allowing students, teachers, and parents to browse by grade band or click a specific category to highlight the lessons that address a specific topic.

access to the same kinds of web-based apps and tools that businesses and consumers have come to expect. Still, at present a school's Internet access may not be the same as your office's, so it's important to make apps and tools that are robust despite less than ideal bandwidth or slowdowns at peak times throughout the day when usage overloads capacity. The State Educational Technology Directors Association (SETDA) recommends that schools and districts meet minimum bandwidth goals (see below). Several public, private, and nonprofit organizations are working to help schools reach and exceed these goals. The Federal Communications Commission is in the process of modernizing its long-standing E-rate program as part of this effort, providing billions more dollars to schools and libraries throughout the country to support their implementation of broadband and wireless technology. While only an estimated 20–30% of U.S. schools now have reliable broadband service to the classroom, these efforts should begin to have a noticeable impact in the near future. To learn more about what schools and district leaders can do to meet ConnectED technology infrastructure goals, see Future Ready Schools: Building Technology Infrastructure for Learning.

Recommended Bandwidth for U.S. Schools

Broadband Access for Teaching, Learning, and School Operations	2014–15 School Year Target	2017–18 School Year Target
External Internet connection from district to Internet service provider (ISP)	At least 100 Mbps/1,000 students and staff	At least 1 Gbps/1,000 students and staff
Internal wide-area network (WAN) from district to each school within the district	At least 1 Gbps/1,000 students and staff	At least 10 Gbps/1,000 students and staff

Source: SETDA, *The Broadband Imperative, 2012*

Testing Your Product in Schools

Developers aim to build apps that work for the greatest number of users, and schools are especially diverse in their infrastructure, organization, staffing, and purchasing. For example, some schools run throughout the summer and others take a break. Some school districts classify sixth grade as an elementary grade and some roll it into middle school. Some school filters block video streaming and social media sites and others don't. The list goes on. This variability is a major challenge, and you may need to limit your initial implementation to specific schools so you can concentrate your resources on core features before adapting to the variations you are sure to encounter. Once you prove that your solution works in one context, however, you won't be able to scale effectively without addressing additional settings and constraints.

Testing an educational app or tool in a school requires coordination with the school administrator and teachers, and it can take some convincing to let teachers take valuable class time for a new app. It can be easier to ask teachers or administrators to test an app that is intended for their own use because then they don't feel they are spending precious student learning time on something unproven. Working with an early adopter educator or co-designing with teachers from the school where you want to test the app or tool can help.

Some organizations are devoted to making product testing in schools easier. Jennie Dougherty's [Beta Classroom](#) was an early nonprofit organization with an organized and systematic approach to teacher beta testing. EdSurge recently started to bring more educator voices to the table through its [EdSurge Tech for Schools Summits](#), but note that these events involve bringing teachers to a centralized location to share apps and tools rather than putting products in the classroom. In Rhode Island, the [Highlander Institute](#) has made inroads with public, private, and charter districts, and it leverages these connections to get ed tech products into more schools and classrooms. Chicago's LEAP Innovations program is similarly working on connecting schools and ed tech companies through its LEAP Pilot Network, as is the Learning Innovation Hub (iHub) in Silicon Valley. EdTech Maryland is laying the groundwork for short-cycle efficacy trials as well.

When working in schools or building apps to use on school networks, developers should understand the implications of acceptable use policies (AUPs) that districts are developing to address concerns about accessing inappropriate materials. These could affect your app or tool because districts may be relaxing policies on filtering or blocking of websites at the school or district level. AUPs are important for protecting school systems from liability as students and teachers consume and create digital media. CoSN (the Consortium for School Networking) created a short guide, [Rethinking Acceptable Use Policies to Enable Digital Learning](#), to help schools develop these guidelines, which can involve parents acknowledging that their child agrees to basic care and responsibility guidelines and student assent that they agree to follow the rules governing their use of the Internet and online conduct. As school device infrastructure has evolved over time, AUPs have also to address one or more of typical usage models: (1) shared digital devices that stay in school (for example, laptops on carts shared by classrooms), (2) student-owned devices under BYOD programs, and (3) one-to-one devices that belong to the school but that students are allowed to take home.

Teacher Support and Training

Teachers find apps and tools valuable only when they know how to leverage them effectively. Therefore, your app or tool should be designed and user tested thoroughly so that teachers can be up and running shortly after downloading it. If data imports are needed (e.g., to set student levels in adaptive software based on benchmark tests), don't assume that a teacher will wait for the IT department to do it—make the instructions clear and simple to follow.

Not every teacher will be an early adopter, and not every teacher will pick up your product with a curious willingness to play and see what it can do. No matter what you build, plan an accompanying professional learning component that outlines the basic

District leaders learn from each other at the Future Ready Summit in Raleigh, NC

structures, functions, and abilities of your tool. An online training module, space for a community of users to collaborate, or co-created collection of suggestions will help more reticent users start to feel at home with

whatever is new about it. As with all things, remember time for training is time educators aren't using to do something else, so make sure to apply user testing of your training elements as well to make sure they actually answer real questions rather than the ones you think teachers will have. As you design training, consider how it will be delivered—on site, remotely, blended on site and online, synchronously, asynchronously? Decide who will develop the materials and who will conduct the training. Will the trainers be employees, paid consultants, or early adopter volunteers? Also, how will you make sure that teachers not only understand your app or tool's features, but also understand and respect the privacy requirement that might be associated with the data your product uses and/or generates?

Ideally, your tool will eventually need minimal training on how to get started because the tool's design will be largely self-explanatory.

Beyond training, how will you communicate with teachers and districts and parents who use your app or tool? For instance, will a support team be available to answer emails and phone calls? Your ability to communicate and work with early adopters may improve the chance for broader adoption from teachers and school districts.

5

Getting Apps and Tools to Users

So you have a great app, but how do you get it in the hands of those who can benefit from it? This section provides insight into selection and procurement process.

District/School Procurement

School district procurement practices tend to be lengthy, which can be challenging for new app developers. The Smart Series Guide to EdTech Procurement from Digital Learning Now! elaborates on the "12 Rules of Smart Ed Tech Procurement." Aimed at state and district leaders, it offers many key questions for them to consider before authorizing a purchase, along with advice on ways to simplify the purchasing process, and gives developers insight into what districts care about. "Improving Ed Tech Purchasing Guide" from Digital Promise, illuminates the thought process of potential users and highlights the challenges in the often complicated process.

Purchasing Examples

Procurement practices vary by district and state, and they can be cumbersome, especially for larger districts (some procurement documents are more than 200 pages). The objectives are to provide fair opportunity for companies to compete for public funds, prevent unapproved purchases, and save costs. The following hypothetical examples (based on actual districts) are representative of the practices that may be in place in districts across the country. When working with a particular district or state, you will need to become familiar with its procurement policies and procedures, including requirements that apply to Federal grants.

Large District (> 40,000 students, > 40 schools). Requests to purchase an app are made to the district to the purchasing department, which issues purchase orders for approved requests. To ensure fair and competitive bidding, district requirements are generally as follows:

- Purchases under $500 require a written quote confirming the price.

- Purchases between $500 and $2,000 require three written quotes from different vendors.

- Purchases between $2,000 and $15,000 require specifications to be sent to the purchasing department, which then obtains written quotes. Purchasing departments may not be familiar with technology purchases, which can introduce delays. Purchase is submitted to the superintendent for approval.

- Purchases over $20,000 go through a formal bid handled by the purchasing department based on

specifications created by the district. Public notice is given (which may not be in the channels where an ed tech company would notice), and comprehensive files are created for each bid received. The purchasing department coordinates the announcement, review, and award of all bids. The board of education approves the final purchase.

From start to finish, a $10,000 request might take 7 to 12 weeks to process, and a $30,000 request might take four to seven months. Some significicnat purchases can take over a year.

Small District (~5,000 students, ~10 schools). A smaller district may have somewhat less formality, but it still must comply with federal procurement policies to ensure fair and competitive bidding. Smaller districts may also be more risk averse and have stricter requirements for smaller dollar amounts. Requirements are generally as follows.

- Purchases under $500 require a verbal quote confirming the price.

- Purchases under $2,500 require three verbal quotes confirming the price.

- Purchases in excess of $2,500 require the superintendent's approval of written quotes.

- Purchases over $2,500 but under $8,000 require three written quotes and must be submitted on a formal purchase requisition.

- Purchases over $8,000 require a formal bidding process that entails a legal notice, sending bid invitations to interested bidders, and formally opening bids at a designated time and place.

From start to finish, a $2,400 request might take between two and four weeks to process, and a $10,000 request might take between eight and 12 weeks.

Charter School (<500 students, one school). According to this 2014 *Forbes* article, "[Illuminating The Edtech Market For Small- To Medium-Sized School Systems]()," many charter management organizations are developing in-house solutions for administration and academic software. For external procurements, the school board must approve any construction-related project expense over $10,000 and any general expense over $5,000, although this policy can be waived under certain circumstances. The head of school has latitude to seek quotes or bids as deemed reasonable. Federal procurement policies apply to all federal funding streams at the school. From start to finish, both a $10,000 and a $30,000 request might take between one and four weeks to process.

Implications and Alternatives in the Procurement Process

Traditional procurement processes have drawbacks for schools and for ed tech innovators alike. If a district determines at the end of a lengthy procurement process that it selected the wrong vendor or approach, it most likely requires starting over and losing precious time, possibly postponing implementation to the following school year. Difficulty changing contracts once they are approved can also stall innovation. Forced to define work six or more months before it starts, districts often cannot nimbly adjust initiatives based on new technology or innovative services.

At the same time, the procurement process can be a time when districts have an opportunity to think through their priorities and requirements (for example, the need for the product to interoperate with a single sign-on solution and to provide data sharing and interoperability). If a district or school is unsure of product capabilities, it can issue an RFI (request for information) to help it assess what products can do. Furthermore,

proposals that come in during the bidding process can provide valuable information, such as price comparison, licensing options, and results from other districts.

On top of developing new products, small ed tech startups often lack the capacity to build large sales and marketing teams. To more efficiently distribute their apps to schools, many developers pursue licensing agreements with larger partners that already have relationships with schools. For example, SBIR awardee Children's Progress developed a math and reading assessment that was distributed by many leading textbook publishers, and Fluidity Software's mathematics software program is distributed by original equipment manufacturers.

Ways to Improve Decision Making

There are things that app developers can do to support schools in making decisions about which digital tools and apps to consider. Here are some possible strategies.

Find an internal champion. If internal champions believe in the importance of the app or tool, they can help make it a priority to get the purchase approved. To do this, introduce the app or tool to district leadership sooner rather than later and leverage teachers' enthusiasm to arrange meetings with key decision makers. Provide these champions with easily sharable information (one-page flyer, short video, etc.) to help them advocate for your tool.

Gain union support. For apps that address a specific teacher need or help make better use of teacher time, teachers unions may have influence on procurement. Make sure the union (through the representing teachers) supports the purchase. Consider meeting with union leaders early in the process.

Secure a place in the budget. Districts often have categorical and general funds that must be spent before the end of the fiscal year. If the purchase of your app or tool is not budgeted in the current fiscal year (often set by March of the prior year), consider providing professional development services, creating a pilot project, or otherwise engaging in groundwork with any available funds to improve your chances of being included in the next year's budget.

Ensure you and your team have met requirements to be on site. District requirements for employment and/or volunteering will most likely apply if you or someone from your team needs to be inside a school for implementation support. Check district requirements early to have time to make sure, for example, that each individual who will be on site has undergone a background check (including fingerprinting). Check for insurance provisions and requirements to comply with labor laws, such as prevailing wage.

Do as much contract prework as possible. Contract terms and approvals can cause delays, so be prepared to negotiate early and be ready once a contract is negotiated. Learn the district's procurement policy and recognize the steps and timelines involved. Prequalify as a vendor for the district. Review standard contract terms and negotiate modifications early. Understand the nuances in both professional service agreements and software licensing agreements (per user, per device, site license, per teacher per classroom, per student, group license, and volume purchase). If a contract must be approved by the board of education, determine when the board meets and the lead time required for getting on the agenda.

Price your app or tool strategically. Different threshold amounts require purchases to be competitively bid and approved by the board of education. Be aware of the cutoffs for competitive bids and approval and be strategic about pricing and selling within district policy.

Distribution Through Third-Party Storefront

Many educational tools and apps can be distributed to schools directly through a digital storefront (such the Apple iTunes Store or Google Play). This typically requires students or teachers to have an account set up on each device but can be streamlined through the use of device management software. If multiple students are using a single device, tracking student progress or app access can be tricky. Some software solutions (such as eSpark) help manage multiple students using a single device.

"Consumer" Education Market

If you want the VC perspective on the potential of the consumer business model applied to ed tech, Fred Wilson of New York-based Union Square Ventures shares his thoughts in this article, Fred Wilson on Ed Tech: 4 Takeaways for Educators and Entrepreneurs. Another perspective comes from Umang Gupta, a Silicon Valley investor and CEO, in his article, Education Technology: Could it Be Different This Time?

Stories From the Field:
Out-of-the-Box Approaches to Procurement

Steve Hodas is an education and online-communities entrepreneur with twenty years of experience ranging from startups to NASA, IPOs to the NYCDOE.

At its root, "procurement" is a system for defining problems, identifying and acquiring potential solutions, and putting them in place. There are many conceivable variations for each of these steps and for how they can be coupled together, but most commonly they take the uninspired form of a conventional Request for Proposal (RFP). The limitations of the RFP process are well known to anyone who has attempted to participate in one. From the vendors' perspective, RFPs can be opaque, tortuous, inauthentic exercises in compliance that seem designed to ensure you do not deliver your most inspired work. From educators' perspective, they often result in products that are at best uninspiring and at worse useless.

But it doesn't have to be that way. Principles of user-centered design (UCD) and crowdsourcing are beginning to make their way into the mainstream of how school districts (and other municipal agencies) solve their problems. The NYC DOE's Office of Innovation has embraced these principles to help improve processes defined at all levels of the system, from the classroom to the school to the central office. Over the past year, they have run several iterations of UCD-based challenges and hackathons to create more authentic solutions to pressing problems. One of the goals is to create exemplars that can be picked up and localized by districts elsewhere.

The GapApp Challenge focused on middle school math classrooms, a Spotify Hackathon on music education, and the most recent School Choice Design Challenge on building apps to help families choose high schools. As different as their end products were, each of these "procurements" was based on the belief that when it comes to looking for answers to hard questions, bottom-up beats top-down and all of us are smarter than any of us.

Sustaining and Growing an App or Tool

It takes effort for schools and teachers to adopt new apps and tools into their technology infrastructure or their classroom practices, so it's important for startups to think about sustainability from the beginning. A panel of seasoned entrepreneurs discussed lessons learned with various sustainability models at an ed tech meetup in 2013, and EdSurge reported the results in the article EdTech Business Models that Work:

> Of the companies represented [Pathbrite, Big Universe, Edmodo, and Global English], only Edmodo is following the Facebook-LinkedIn model of building a huge audience with support from hefty venture capital. Even so, Andreas Quandt, head of product and analytics at Edmodo (and formerly with Facebook), noted that entrepreneurs should realize that ed tech isn't like the consumer web: "You should not go into this space for financial reasons," he cautioned. "You need to have the vision and conviction that you can build the right product and do everything right. And you will need a lot of patience and perseverance and grit."

With that caution in mind, the following are some common approaches to building sustainability for your tools and apps in the education space.

- **Freemium for teachers, students, or parents.** Offer a basic version of your app for free and encourage teachers or parents to purchase the premium version with added features. The advantage is you can build a large customer base through the free version, with the downside being the need to convert enough users to purchasing the premium version to make ongoing development sustainable. Also, if teachers or parents are downloading an app or tool to try it out, the freemium version should give them enough information about how it works to be able to make a confident purchasing decision.

> ## Watch out for Advertising!
>
> While many of the approaches presented here will be familiar to app developers who have worked in other spaces, there is an important difference. Producers of consumer-focused apps often fund the development of their app through advertising in the app. In education, this may not be appropriate because it can be distracting to learning and can repel parents and teachers. District policies may even prohibit the practice.

- **Freemium for schools.** Offer your app or tool for free to teachers or students and then charge schools/ districts for the premium version, which could come with additional reporting or integration to enterprise data systems that could be useful at the school or district level.

- **Direct to parents.** With the proliferation of mobile devices and the ease and familiarity of purchasing and downloading apps from education app storefronts, making your business sustainable through parent purchasing is a possibility.

- **License to other companies.** Consider making an arrangement with a platform provider or content aggregator to offer your app to students, teachers, and/or schools through an existing distribution channel.

- **Enterprise or institution.** Enterprise sales are familiar in the education marketplace but can be difficult for startups with a small sales force and can take a long time. Focusing on the region in which you are based and generating referrals from early implementations can help you connect with decision makers in other regions.

- **Value-added services.** Offering your tool or app for free and offering services such as technical support, professional development, or analytics in connection with your app or tool can make it more appealing to the education sector. This can be a way to provide sustainability for the development of your tool without charging for the app itself.

6 Software Interoperability and Open Data

Schools have a lot of data—everything from student grades to library management to bus schedules or transcript generators. Often these data are stored in a variety of stand-alone systems that don't share their data in a standardized way. This means that the same data, such as teacher names or student schedules, must be entered manually into each system that needs the data to function properly. New tools and apps may find it challenging to exchange data with existing school data systems. The situation worsens with the increased use of online learning systems that depend on student data to personalize instruction and provide reporting to teachers. As teachers and students go online for more of their teaching and learning needs, the number of systems they rely on increases. This makes it very difficult for teachers and students to see a comprehensive picture of their learning progress or know where students are struggling and for teachers to give them effective support.

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

Single sign-on. Apps and tools can be built to enable single sign-on—allowing teachers and students to log in to all their applications with a single password. This is similar to how general Internet users may log in to a variety of sites using their Facebook or Google account, only in the case of students the accounts would be provided by the school.

A teacher teaching six classes of students a day with multiple apps and tools needs a way to manage learning content, attendance, student progress, and grades. Students and teachers having to keep track of a different user name and password to log in to each system wastes time and creates frustration. In addition, if all the different learning systems don't know who a student is, they can't help schools create a complete picture of that student's learning. For all these reasons, solutions involving single sign-on are needed for teachers and students to access all their technology solutions though a single log-in credential. Many districts are even moving from preferring single sign-on to requiring it.

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

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

App developers should also consider offering users the ability to export information in case they need to use it in another tool or app. Google Takeout is an example of this, allowing users to export any of their data from a Google tool for use on other tools if they choose.

If app and tool developers can come together to create and use open standards so that teachers can use any platform in tandem with any additional applications that they find useful, this would greatly reduce barriers to empowering teachers to select the best tools for their needs.

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

- The [Common Education Data Standards](#) (CEDS) are a good anchor to help center the debate, but they do not specify how the data are actually transferred.

- The [Schools Interoperability Framework](#) (SIF) is an open data sharing specification that does this. SIF has an [XML](#) specification for modeling educational data and [service-oriented architecture](#) (SOA) specifications for sharing the data between institutions.

- Organizations such as the nonprofit umbrella organization [PESC](#) are busy working with many kinds of organizations to unify educational data.

- [Ed-Fi Alliance](#) is working to create common data standards for communication between educational tools. Ed-Fi is different from SIF because it is focused on providing educators with dashboard starter kits showing real-time data displays.

Ed-Fi and SIF both align with existing local systems as well as federal standards such as CEDS, and they can both help lower the time and money spent on state- and federal-level reporting, if implemented effectively. There are also some new alternative approaches to sharing data, discussed below, such as Experience API (xAPI).

Early-Stage Interoperability Initiatives

The Experience API (xAPI)

When students are learning across multiple technology applications, that information is scattered among many different systems. xAPI is an approach to describe learning data between systems in a uniform way.

Source: Overview of xAPI by Liz Burow

xAPI helps collect experiences from online learning activities (such as watching a video or completing a quiz). These data can then be used to help other learning systems give students a more personalized experience, as well as help a teacher understand a student's unique needs based on his or her activity across multiple learning tools. Because xAPI is simply a protocol to describe learning actions (John watched a video, Kelly completed a quiz, etc.), any type of learning experience can be placed into this format. This means that it could be used to account for more social and emotional skill sets (resilience, perseverance, etc.), which is a potentially big improvement over a reliance on hard outcome data in most digital systems. xAPI is available under an open license from the Advanced Distributed Learning Initiative.

Learning Resource Metadata Initiative

Searching for digital content is much easier when resources are tagged: Recipes, travel directions, and airplane ticket information all have common fields (e.g., who, date, location, subject, publisher) that can improve search results for users. The Learning Resource Metadata Initiative (LRMI) is designed to make it easier to publish and discover digital learning resources through the use of common tags. Because learning resources have fields (such as curricular standards alignment) that are not found in other web searches, LRMI was created to describe those unique educational elements.

LRMI was built as an extension to Schema.org, a metadata vocabulary developed as a collaboration among Bing, Google, Yahoo!, and other organizations to encourage the use of metadata to make it easier to find web resources. The LRMI metadata vocabulary is based on contributions from experts and organizations that have worked with metadata and metatagging since the early 1990s and thus comprises the best of existing systems rather than a reinvention. This metadata framework enables creators of learning resources to tag them consistently and effectively.

The Learning Registry

The Learning Registry is a tool for collecting and sharing information about digital learning resources. Its goal is to help educators and students access the right learning content for their specific needs. It does this by providing a common location to post information about which learning resources are relevant to which users. Similar to how a library card catalog provides information about all of the books in the library in one place, the Learning Registry provides information about digital learning resources across the internet in one place. Posts to the Registry may include the author and date created, as well as the curricular standards to which the content is aligned. The Learning Registry also records usage data for each object (e.g. 543 eighth-grade science teachers used the attached video last month). Like the card catalog, the Learning Registry does not store the actual learning resources, just information about them with links to the location of the resource itself.

App developers can use the data from the Learning Registry to recommend digital learning materials to users without having to collect all of the content themselves. Sites like My Digital Chalkboard and Illinois Shared Learning Resources use data from the Learning Registry to helps users find relevant resources.
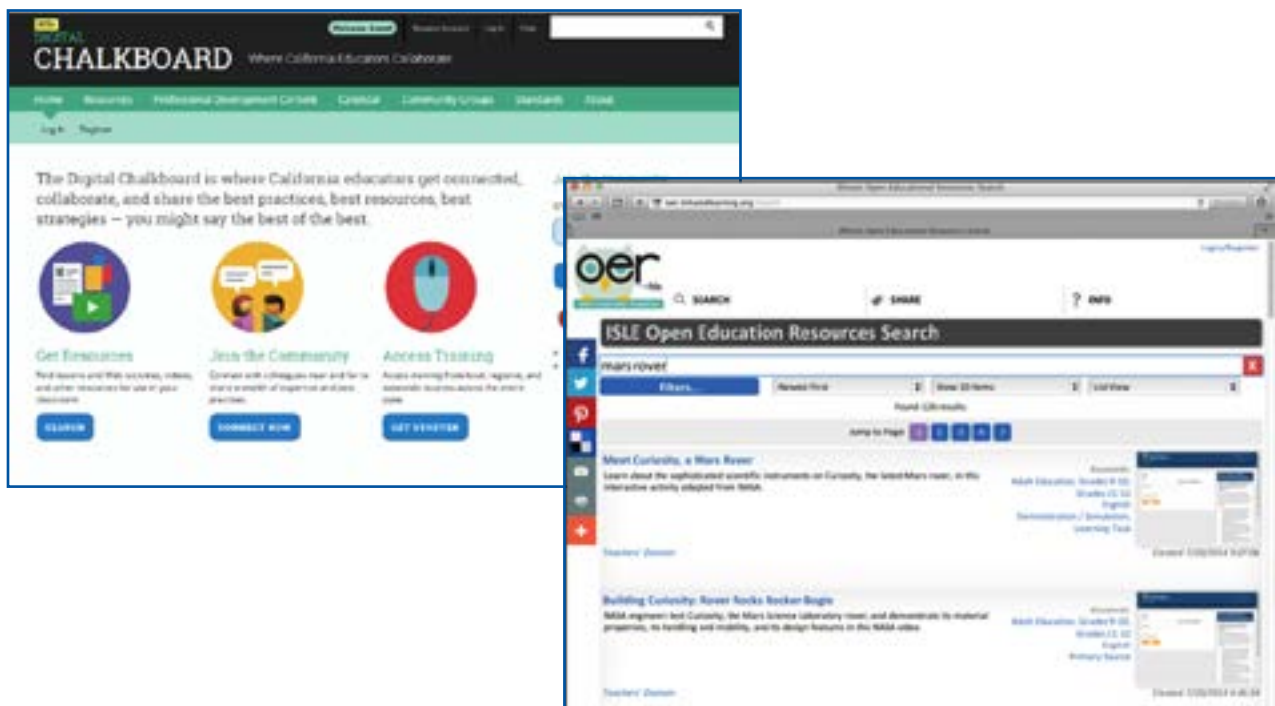
My Data Initiative

The MyData Initiative seeks for every student (or parents of a younger students, as appropriate) to have access to his or her own academic data, wherever the data are stored, in both *machine-readable* and *human-readable* format. As the MyData website explains,

> This is possible through the participation of schools and software developers who enable students to download their own data to create a personal learning profile that they can keep with them throughout their learning career. In addition, developers are encouraged to create customized services and tools

for students based on the information available in their personal learning profile.

This data may range from classes taken to their federal financial aid (FAFSA) details. Students can simply retain this information for their own records or benefit by sharing select pieces of it with the ever-growing network of applications being built by the private sector to help students make better choices about which classes to take, which colleges to attend, and how to pay for tuition.

Stories From the Field: A Case Study from Data Jam/Datapalooza

Mike Hruska is the CEO of Problem Solutions, which specializes in software, mobile and learning technologies for government, nonprofit and commercial partners. Hruska's firm has worked on mobile strategy for the U.S. Army and developed mobile technology to distribute movies for Paramount and Disney.

"The U.S. Department of Education hosted a [Datapalooza](#) in January 2014 to bring together private sector technology innovators and educators to build tools to support learning. One of the projects was edX Connector, built jointly by the Advanced Distributed Learning (ADL) Initiative, Aptima, Carney Labs, edX, Parchment, Problem Solutions, Syracuse University, and the World Bank. The group realized that as more platforms for learning emerge, learners will have more places to access personalized learning experiences. Its goal was to enable platforms like edX to share availability of courses through the Learning Registry, to collect user-learning paths using the Experience API (xAPI), and to share learner profile data between learning platforms using a profile API.

With only 30 days to build the demo, the group used existing technologies as much as possible.

- Existing platforms and technologies: Learning Registry, edX

- Specifications and standards: Common Core Standards, PESC Standards, xAPI

- Collaborative and open-source tools for codevelopment (e.g., GitHub, Google Docs).

The group fleshed out three use cases and showcased the possibilities of its work at the January 2014 Datapalooza:

1. Publishing the existence of an edX MOOC (massive open online course) to the Learning Registry to make others aware of it

2. Capturing and sharing granular learning path data within a MOOC (in the form of a student profile) to share an experience with a learning resource

3. Sharing (exporting) a profile for a user.

By enabling universities to share course content and students the ability to transfer prior achievements, edX Connect builds a stronger ecosystem to expand personalized learning offerings. Questions like the following can be considered: What did you learn, how did you learn it, and what is your record of achievement? The edX Connector offers a first step toward this functionality."

As one example described in this article, "Personalizing Analytics through the Education and Career Positioning System," the MyData Button was used as part of an Iowa college and career guidance system that enables individuals to design, simulate, and create their education-to-career choices and pathways and, when they desire, to download all their personal data records.

Open Badges

The Open Badge Initiative is an example of an innovative infrastructure for colleges and industry organizations to award microcredentials to students who demonstrate proficiency in specific competencies. A student may earn a particular competency badge by demonstrating prior experience or by participating in courses or informal learning experiences. When badges are delivered using the Open Badge specification, a learner can collect badges from any number of different organizations and showcase them in one single place. Eventually, employers may use Open Badges to search for new employees who have specific competencies, leveling the playing field for job seekers while better matching skill sets with positions.

Sources of Education Data and Resources

The open education movement has made data about education and learning materials freely available to be used to improve learning experiences for students everywhere.

Open Educational Resources

Open Educational Resources (OER) are teaching, learning, and research resources that reside in the public domain or have been released under a license that permits their free use and repurposing by others. Open educational resources include full courses and textbooks, down to individual images, videos, or assessments. The OER movement became popular when Massachusetts Institute of Technology launched MIT Open Courseware in October 2002, making all of the materials used in the teaching of MIT courses available for free on the Web. Washington, Utah, Illinois, and California have all set up programs to help their educators access and share OER.

Open Educational Data

The open data movement provides datasets that can be freely used in the development of tools and apps for education. Data.gov is a repository of nearly 300 open educational datasets from the federal governement, ranging from names and addresses of all schools in the country, to dropout rates by college, to areas of teacher shortages. These datasets can be used to create apps that help students make informed choices about college, visualize educational trends, improve career planning, and compare educational institutions. The following summarizes some particularly useful education datasets on data.gov.

- The Integrated Postsecondary Data System (IPEDS) gathers information from more than 7,000 U.S. colleges and universities. Institutions report data on enrollment, program completions, graduation rates, faculty and staff, finances, institutional prices, and financial aid. IPEDS offers information about college access, comparative pricing, graduation rates, degree types, instructional costs, finances, and on-campus crime.

- [Civil Rights Data Collection](#) (CRDC) collects education access and equity data by race/ethnicity, sex, English proficiency, and disability. The collection captures elementary and secondary school data on education access and opportunities, including access to college- and career-readiness courses, teacher equity, school expenditures, retention, access to pre-K programs, athletics, restraint and seclusion, bullying and harassment, and discipline. The CRDC also provides information on athletics and teacher salaries.

- [Common Core of Data](#) (CCD) provides an official listing of all public elementary and secondary schools and school districts in the nation. The CCD provides information on student population characteristics by gender, race, and grade; the number of schools that opened and closed each school year in every state and school district; the percentage of students attending charter schools; the teacher-to-student ratio; high school completion rates; employee salary and benefit information; and per-pupil expenditures.

- [EDFacts](#) is a U.S. Department of Education initiative to put performance data at the center of policy, management, and budget decisions for all K–12 education programs. It is the central collection system and national repository for federal program information on state, district, and school performance measures. EDFacts provides data on the percentage of students reaching grade-level proficiency in reading or math, the percentage of a ninth-grade cohort that graduated in four years, and the proportion of a district's Title I schools that have been identified as needing focused attention or improvement.

- The [Federal Student Aid Data Center](#) is a repository for information on the more than 9 million Pell Grants and over 23 million student loans disbursed annually. This data center provides institutional-level data on how much each postsecondary institution receives in the student aid programs each year, along with performance information like the student loan default rate. It also contains information on earnings and loan repayment for vocationally oriented programs.

- The [National Student Loan Data System](#) (NSLDS) is the U.S. Department of Education's central database for student aid. NSLDS receives data from schools, guaranty agencies, the Direct Loan program, and other Department of Education programs. NSLDS Student Access provides a centralized view of Federal Student Aid so that aid recipients can access their federal student loan and/or grant data. It also offers an implementation of the MyData service to enable download of personal data. NSLDS contains extensive data on federal grants and loans provided to individual students along with their background information. There are

Education Secretary Arne Duncan visits with app developers at an Education Datapalooza

a variety of potential applications for these data, such as student financial and educational advisement, personal management of financial aid, search assistance for supplementary financial aid, or services targeted to financial aid recipients.

The U.S. Department of Education encourages the use of open government data to develop tools and apps to help students and their families. From time to time the Department hosts events that bring diverse stakeholders together to brainstorm ideas for app development based on open data. Over a course of 90 days the participants are encouraged to design new apps or integrate data sets into existing apps in new ways. Products are then displayed at a Datapalooza event to highlight the apps and tools that use open data in helpful ways. Visit tech.ed.gov/datapalooza to see examples of apps, or visit tech.ed.gov/open-education to learn more about the Department's open education initiatives.

7 Important Trends in the Education Landscape

Whatever topic or skill you decide to focus on, you are sure to encounter some of the major educational trends highlighted here. Some of the most interesting innovations in K–12 are happening around them and because of them. In addition to the specific practices outlined below, the District Reform Support Network has published case studies of lessons learned in four of the Department's Race to the Top – District grantees. The case studies can provide in-depth understanding of what innovative practices look like within districts as well as initial lessons learned in how those practices have been adopted.

Stories From the Field: From Academic Research to Tools for Classroom Practice

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"Mary Kalantzis and I have always tried to translate our research into practice. In the past, this was by producing curriculum resources. However, over the past few years we have translated our research into software—the Scholar writing and assessment environment. This would not have been possible without the support of IES—both through the SBIR program and technology transfer in the case of IES grants to the university. Scholar realizes everything we have been arguing for in our research work for the past several decades. In Scholar, students can produce multimodal pieces of writing, including images, videos, audio, and datasets (in fact any digital media), inline, within the writing. These are published into personal and class web portfolios. Scholar is an environment for creating informational texts or write-ups of experiments in science or digital storytelling. Our research has also focused on writing assessment, so Scholar includes multiple forms of assessment (rubric-based review by peers, self, and/or teacher; in-text annotations; item-based surveys; and a dashboard that brings together overall results). Now we're on the path to commercialization and creating a self-sustaining enterprise. Our spin-off, Common Ground Publishing, is located in the University of Illinois Research Park, and we have licensed the IP from the university. Already, we have schools that have licensed Scholar from us directly and publishers who have provided content, and we are currently in discussions with potential distributors."

Blended Learning

Blended learning is an important support for transforming teaching and learning to increase individual student performance. It goes beyond adding technology to an existing learning flow. In a blended learning environment, part of the learning occurs online and part occurs face to face. Both the online and face-to-face experiences are parts of a whole. They are blended into a seamless, integrated learning experience where learning in each environment informs and supports the other. The Christensen Institute categorizes blended learning variations and gives examples. A key element of most definitions of blended learning is the ability for a student to have some control over time, place, path and/or pace.

Usually, the online time is personalized, so students can go at their own pace, get extra practice and remediation if they need it, and follow their interests to the degree that the software supports that kind of personalization. In many blended models, the students spend some of their face-to-face time with the teacher in a large group, some face-to-face time with a teacher or tutor in a small group, and some time learning with and from peers. Technology may also support these face-to-face interactions.

Blended learning makes classrooms look and feel fundamentally different. The following video resources demonstrate the practice:

- What is Blended Learning? From The Learning Accelerator; an overview of blended learning (5 minutes)
- Phaedrus Initiative: Blended Learning. From Seton Education Partners; shows data-driven instruction, assessment, and differentiation in the first year of a blended learning program in San Francisco (9 minutes)
- Blended Learning Energizes High School Math Students. From Edutopia; educator Peter McIntosh helps his students take ownership of their learning by using interactive subject-mastery tools like Khan Academy (5 minutes)
- Blended Learning at the RI Model School. From The Highlander Institute; shows blended learning using a classroom-rotation model in an elementary school (3 minutes)
- KIPP Detailed Blended Learning. From KIPP Empower Academy; an example of blended learning across grade levels (9 minutes)

Standards for Learning

Each state maintains a set of learning standards—skills that students must master at each grade level. These learning standards serve as a map for the lessons and activities that teachers create. They are also the foundation on which state assessments are designed. The Achievement Standards Network provides a machine-readable list of all state standards.

Developers providing content solutions will need to know how their tools and apps align with the learning standards for a specific state. One of the first questions a teacher or district leader will ask about a tool or app is how well it supports improving student outcomes on state learning standards.

There are several learning standards initiatives that are important to know about if you are developing tools and apps for the U.S. K–12 audience.

Common Core State Standards. Until recently, each state had its own learning standards in all subjects. This can make it difficult for tool and app developers who may need to create 50 different versions of their app to meet the various state standards. Several years ago, a number of states led an initiative to develop consistent, real-world learning goals in math and English language arts. This effort, known as the Common Core, helps ensure that all students, regardless of where they live, graduate from high school prepared for college and career. Apps and tools that align with the Common Core can be used across multiple states without needing to be redesigned. You can view the standards as well as the states that have adopted the Common Core at www.CoreStandards.org.

College and career ready standards. A number of states have not adopted the Common Core State Standards but have instead adopted separate college and career ready standards. In these cases, a network of institutions of higher education in each state has certified that students who meet the curricular standards will be prepared to enter college without remediation upon graduation from high school. To be successful in these states, you will need to align your tools to individual state standards.

Next Generation Science Standards. The Next Generation Science Standards (NGSS), a research-based set of interdisciplinary science standards across all grade levels, are similar in aim to the Common Core State Standards. They are not yet as widely adopted, but the number of states embracing them is growing.

C3 Framework for Social Studies Standards. The College, Career and Civic Life C3 Framework was created by state agencies and leading organizations in social studies and its individual disciplines to help districts and states create standards for effective participation in college, career and civic life. They are also not yet as widely adopted, but the number of states embracing them is also growing.

Testing/Assessment

When selecting a problem to solve or when talking to educators about what concerns them, you will find that standardized testing often comes up because schools are held accountable for student performance. Test scores affect teachers, administrators, and even local housing prices because many parents equate high test scores with school quality when considering making a move to a new neighborhood. Test scores even affect the school year calendar because any ancillary activities stop just before and during test weeks. Some of the major standardized tests are described below.

To receive federal funds, each state must adopt statewide assessments in mathematics, English language arts, and science that are aligned with their content standards. To help states meet this requirement, the U.S. Department of Education funded two assessment consortia to develop assessments in mathematics and English language arts:

PARCC. The Partnership for Assessment of Readiness for College and Careers (PARCC) is a consortium of states developing a common set of K–12 assessments in English and mathematics. PARCC assessments are aligned with the Common Core State Standards and replace annual assessments in states that transition to these online exams. As a result, these assessments provide data on student proficiency across state lines.

Smarter Balanced Assessment Consortium. The Smarter Balanced Assessment Consortium is a state-led consortium developing next-generation assessments that accurately measure student progress toward college and career readiness. The Smarter Balanced assessment system is aligned with the Common Core State Standards.

No state is required to adopt either PARCC or Smarter Balanced in order to receive federal funds. Alternatively, a state may adopt its own assessments aligned with its content standards.

NAEP. Commonly referred to as the Nation's Report Card, the National Assessment of Educational Progress (NAEP) is a national test administered periodically to gauge, through a sample of districts across the nation, students' knowledge and skills in various subject areas. The NAEP helps determine how states and urban districts compare on student growth and achievement over time. It assesses math, reading, science, writing, the arts, civics, economics, geography, and U.S. history. The newest test to be released in 2014 will be on technology and engineering literacy.

TIMSS. A global assessment is the Trends in International Mathematics and Science Study (TIMSS). This assesses fourth- and eighth-grade students' math and science achievement. Administered every four years, the next TIMSS assessment will be in 2015. In 2011, a total of 500,000 students from more than 60 nations took it. Given the growing emphasis on measuring students' competencies based on both statewide and international benchmarks, the value and importance of the TIMSS assessments will most likely increase in coming years.

Personalized Learning

Personalized learning is a core part of the vision sketched by the National Education Technology Plan. Personalization puts students at the center, empowers them to take control of their learning, and offers engaging learning experiences for all learners.

Personalization can be a great asset to a teacher in the classroom because it expands his or her ability to provide tailored support for individual students' needs. One-on-one instruction, particularly for struggling students, can be much more beneficial than instruction with the whole class. Technology to support personalized instruction can serve as an extra pair of hands for struggling students, or it can provide enriching opportunities for students performing above grade level.

Individualized, Personalized, and Differentiated Instruction

Individualization, differentiation, and personalization have become buzzwords in education. The following are the definitions used by the U.S. Department of Education:

Individualization refers to instruction where the pace is adjusted to meet the needs of individual learners, allowing them to progress through the material at different speeds.

Differentiation refers to changing the instructional approach based on the needs of individual learners. Learning goals are the same for all students, but the method or approach of instruction varies according to the preferences of each student or what research has found works best for particular students.

Personalization refers to instruction that is paced to learning needs and tailored to both learning preferences and specific interests of different learners. In an environment that is fully personalized, the learning objectives and content as well as the method and pace may all vary.

Instead of having all students participate in the same activity at the same time, teachers have more flexibility. Some students can be engaged in personalized learning on computers or tablets, some can gather in small-group instruction with the teacher, and some can participate in small-group centers.

Finally, most personalization programs give teachers the ability to obtain an overview of how their students are doing in a class. The ability to quickly assess which students have grasped a concept and which haven't—without wasting class time giving and checking quizzes—is invaluable for teachers.

For more on personalized learning, consider the series of reports from *Education Week* as well as the Race to the Top & Personalized ED report which provides a summary of ED's peronalized learning grant program.

Project-Based Learning

Project-based learning makes learning meaningful and teaches skills that cut across many content areas: creativity, collaboration, leadership, and the like. Learning takes place in the context of authentic problems, continues over time, and brings in knowledge from many subjects. In this way, students can be assessed on their ability to apply knowledge to real-world problems. The New Tech Network helps schools implement project-based learning, and they offer a rubric to evaluate project ideas.

Another good set of resources on project-based learning can be found at the Buck Institute for Education (BIE). The BIE website provides a set of answers to the question of why project-based learning as well as collected research on the utility of project-based learning. Examples of project-based learning in action can also be found on Edutopia's site. Project-based learning, if properly implemented and supported, helps students develop 21st century skills and engage in complex, real-world challenges that help them meet new standards for critical thinking.

Mastery-Based Learning

Also known as mastery learning, competency-based learning is a growing focus of education conversations. The premise is that students learn best by mastering a particular learning goal before moving on to new material that builds on that goal. Instead of a group of students all moving from one topic to the next with varying degrees of understanding, each student continues to work on a topic until he or she has mastered the content. Because students of the same age advance through the curriculum at significantly different paces, schools that use this approach can no longer use a traditional model. In the mastery-learning model, educators design progressions of sequential learning goals that progress from simple knowledge and skills to complex tasks. For this to work well, the goals must be personalized so that they are challenging to students but not too frustrating to achieve.

Mastery learning has an assessment counterpart: standards-based grading (not to be confused with standardized testing). Instead of averaging a student's general achievement over a period of time and representing this as a grade, teachers in mastery systems evaluate student performance in specific topics and skills and categorize their performance in levels of mastery, such as "advanced," "proficient," "basic," or "below basic." In a true standards-based grading system, students do not progress until they demonstrate proficiency. See Robert Marzano's "Formative Assessments and Standards Based Grading" for an in-depth look at mastery learning.

Teacher Certification

Teachers are certified to teacher either through traditional teacher education programs or through alternative certification programs. Certification is generally the responsibility of the state. Traditional teachers are certified by completing a bachelor's or master's degree in education, after which they typically receive a preliminary probationary certification. Then they must fulfill other requirements—additional tests (usually a Praxis test), participating in

a certain number of hours of professional development, student teaching, completing an induction program, or getting a master's degree, depending on the state—in order to receive permanent certification. Advanced teachers can receive credentials from National Board Certification, a "rigorous, peer-reviewed process that ensures that Board-certified teachers have proven skills to advance student achievement."

Alternative certification programs, designed to expedite nontraditional pathways into the classroom, began in the 1980s and have proliferated in the past decade. Some programs labeled alternative are more rigorous and take even longer than traditional programs, whereas others are fast tracked and have little or no practical training. Some of the large alternative programs are Teach for America, The New Teacher Project, and the American Board for Certification of Teacher Excellence; many smaller residency or online programs are also available. Alternatively certified teachers accounted for approximately one fifth of the teaching force in 2006, and that number has only grown since. Teachers with alternative certifications come from a wider array of backgrounds, many having worked in other professions for years before transitioning to teaching.

Keeping Up with Ed Tech

As the ed tech space continues to grow, so does the number of media web sites and individual bloggers. Below are several sites useful for keeping up with ed tech news.

- EdSurge. The EdSurge weekly online newsletter is widely read in the ed tech community. EdSurge also produces ES-Instruct for educators and the EdTech Index, a database that categorizes and reviews hundreds of ed tech startups, products, and services.

- Education Gadfly: Weekly ed tech updates produced by the Thomas Fordham Institute.

- EdTech Times: Boston-based group whose site features daily news updates and features.

- Edutopia focuses on practices and programs that help students acquire and effectively apply the knowledge, attitudes, skills and beliefs to achieve their full potential.

- EdWeek Digital Directions. Part of EdWeek, Digital Directions covers news, trends, and best practices for the K–12 tech audience.

- EdTech Handbook is a series of contributed articles hosted at edtechhandbook.com.

- eSchool News provides the latest educational technology news K-12 and higher education.

- Getting Smart: Created by Tom Vander Ark, the Getting Smart site covers formal and informal topics that cover K-12, higher education and lifelong learning. The organization has a particular focus on innovation and personalized learning.

- Graphite. Created by Common Sense Media, Graphite provides reviews of ed tech products where educators can filter results by type (app or website), subject, grade level, and price. Product information provided includes setup time, skills addressed, intended student audience, and tech notes. Designed for educators, the products are reviewed by volunteer teachers who use a review system that examines pros, cons, engagement, pedagogy, support, and the bottom line.

- KQED MindShift. If you're looking for a deeper dive into topics related to learning, check out MindShift. Launched in 2010 by KQED and NPR, MindShift explores the future of learning in all its dimensions, including cultural and technology trends, innovations in education, groundbreaking research, and education policy.

- New Learning Times is produced at the Ed Lab at the Teachers College at Columbia University and provides daily coverage of learning opportunites to transformation education.

- Startup Digest EDU shares the latest news and information about startups and innovations in education.

- Tech and Learning: Published by New Bay Media, Tech and Learning includes a website, newsletter and monthly magazine. Both a website and monthly paper publication, Tech and Learning focuses on ed tech professionals responsible for implementing and purchasing for K-12 schools.

- THE Journal is dedicated to informing and educating K-12 senior-level district and school administrators, technologists and tech-savvy educators on educational technology issues. .

Twitter chats and hashtags can also be great resources for identifying important trends and issues in educational technology. Here is schedule information and hashtags for education Twitter chats.
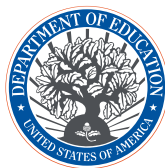
Final Words of Advice

Joseph South is the Deputy Director of the Office of Educational Technology at the U.S. Department of Education. Prior to joining the Department he led the development of educational products for Middlebury Interactive Languages and the National Baseball Hall of Fame.

"To an outside observer, it may appear that public education in America is changing very slowly or not at all. Nothing could be further from the truth. Like the calm surface of a deep and powerful river, there are massive, irresistible forces moving swiftly below the surface that will fundamentally reshape our schools. Not all of the forces are positive. Poverty among public school students is increasing, not decreasing. Some forces are neutral. The diversity of our schools is growing rapidly and permanently, providing both opportunities and challenges. Some forces can change our schools completely or not much at all. Technology falls in this category.

Tens of thousands of schools and millions of students will have access to broadband in their classrooms for the first time over the next twelve to twenty four months. But access doesn't lead directly to change. Technology is an accelerator; it allows us to scale the reach of what we have chosen to do with astonishing speed. But it doesn't make our choices transformational. It can just as easily scale the bad as the good, the minimally effective as much as the incredibly impactful. This is why the conversation must begin with a well-grounded, transformational vision of learning itself. With that goal firmly in mind, we can then bring to bear the power of technology to enable, measure, iterate, and refine our methods of achieving that vision.

And this is why we need you. Help us articulate that vision and find that path."