# The State of Edtech

How Edtech Tools Evolve: Part 3 of our Yearlong Series

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As a nation, we obsess about education. Look at *A Nation at Risk*’s 1984 critique that public education would not bring about a competitive economy. Or maybe *Eisenhower’s National Defense Education Act*, aimed at increasing science education for national safety in 1958. Or go back to 1930 to *Eleanor Roosevelt’s* speech in Hyde Park when she called for an improvement in education to build better citizens.

As more and more people chime in—whether they be teachers, administrators, business people, entrepreneurs, politicians, foundations, social workers or technologists—our conversations over what we teach, when, why and how we teach it, have become more polarized. Each group brings its own views on how teaching and learning has and should evolve.

Each group of people looking to education to solve problems or serve as a mechanism of change is looking at the world through their own lens. Maybe it’s political, economical, justice-oriented or relationship-focused. Each person uses their lens to define what teaching and learning should look like.
This project invites you to try on different lenses when looking at K-12 education in the US. We will give you perspectives from different stakeholders on the trends and forces shaping how money is invested, how tools are created and how schools are designing teaching and learning experiences.

We all have a huge stake in education, as parents, as community members and as learners ourselves. However, the only way we can collectively move education forward is if we start trading lenses and begin building a better understanding of how other communities see teaching and learning.

Please share and take the opportunity to “regrind your conceptual lenses” to gain a different perspective on the evolution of teaching and learning.

A Message from AT&T

Technology is fundamentally altering education by removing barriers so that everyone—regardless of age, gender, income or zip code—has the opportunity to make their dreams a reality. AT&T is helping to drive this change by developing tools for anytime, anywhere learning and supporting change-makers in education. By gathering and analyzing information about the current state of ed-tech, we can create and support the most effective solutions—and ensure other companies are doing the same. Through our signature education initiative AT&T Aspire, we are providing funding and collaborating with EdSurge to support “The State of EdTech” research.
How Edtech Tools Evolve

INTRODUCTION: WE’VE HEARD THIS BEFORE

Great inventors have proclaimed technology’s potential to transform education before. In 1913, Thomas Edison asserted that “books will soon be obsolete in the public schools,” replaced by motion pictures. Nearly a century later, Steve Jobs, according to his biographer Walter Isaacson, believed print textbooks were “ripe for digital destruction.”

Not so fast. Over the decades, a parade of technologies—television, “teaching machines,” interactive whiteboards and desktop computers—seemed to have a far more muted impact on learning than futurists and entrepreneurs predicted. Even the trusty wood-pulp book still soldiers on: Roughly half of district IT leaders surveyed by the Consortium for School Networking believe that print materials will still be used regularly by 2018.

“The pattern of hype leading to disappointment, leading to another cycle of overpromising with the next technology, has a long history to it,” notes Larry Cuban, an education professor at Stanford University who began his career as a high school history teacher in the 1950s.

And yet, puncturing this bleak scenario are shining examples of times when technology has made a difference. In North Carolina, educators at Mooresville Graded School District (hailed by The New York Times as the “de facto model of the digital school” in 2012) attribute a boost in test scores, attendance and graduation rates to the smart use of laptops and online software (earning itself the title). In rural Central California, Lindsay Unified School District’s ongoing efforts to refine its competency-based learning model has led to small bumps in test scores—but a dramatic drop in truancy, suspension and gang membership rates.
So what’s the difference? When can technology have a galvanizing effect, rather than amplify existing educational practices?

Kentaro Toyama, a professor at University of Michigan’s School of Information, has often observed the latter. How can new practices extend beyond just a single class or a hero teacher, but for a community, and on a sustained basis? What portion of the answer lies with technology—and what portion with how it’s used?

This chapter of our year-long survey of the role of technology in education dives into technology’s contribution to that fragile equation. And arguably one of the most thoughtful perspectives on technology’s role in education comes from Ruben Puentedura, a former teacher and university media center director. His investigation into the role of technology in education in the late 1980s led to an observation that was simultaneously clear-eyed yet profound: Not every device or app can or should transform how teachers teach.

To wield technology well, Puentedura asserts, teachers must ask and answer: “What opportunities does new technology bring to the table that weren’t available before?” Puentedura codified his observations in a framework nicknamed “SAMR,” which offers an invaluable window into understanding the different ways that technology can support changes in instructional practices and learning outcomes.

Yet there is a non-negotiable requirement for technology to make a difference. It has to work without requiring herculean workarounds.

Sometimes the lynchpin requirements are technical. Electric cars were infeasible without lithium batteries and lightweight composites. Sometimes the requirements also involve structural issues. Digital readers and e-books first came to market in 1998, but it took nearly a decade to resolve problems around limited memory and storage, title selections, copyright, conflicting file formats and other technical issues before e-books captured significant consumer market share.

TRANSFORMING EDUCATION THROUGH TECHNOLOGY

by AT&T

Mobile technology, applications, and services are empowering students to achieve, removing barriers to graduation, enabling teachers, and preparing today’s learners for the jobs of tomorrow. Through the AT&T Aspire Accelerator, AT&T invests in startups that share the company's goal of transforming education through technology. The six month program is designed to accelerate the startup organizations—both for- and non-profit—that have the potential to improve student success and career readiness. Participants receive a financial investment, access to expertise, services and relationships tailored to their organization and expert mentors from the education and technology ecosystems.

The pattern of hype leading to disappointment, leading to another cycle of overpromising with the next technology, has a long history to it.

Larry Cuban, emeritus professor at Stanford University
Chapter 3: Introduction

For educators to be able to count on technology, it has to work with the reliability of a lightswitch. And for decades, it has not. Just eight percent of all computers in U.S. public schools had internet access in 1995. A decade later, that figure jumped to 97 percent—yet only 15 percent of all public schools enjoyed wireless connection. Software incompatibility and technical problems, such as creating and managing accounts, proved problematic for educators. Nearly half of the educators surveyed in 2008 by the National Education Association reported feeling adequately prepared to integrate technology into instruction. Fewer than one-third used computers to plan lessons or teach.

Today, more than 77 percent of U.S. school districts offer bandwidth speeds of 100 kbps per student for accessing online resources. This, coupled with cloud computing services that allow apps, services and data to be accessed and shared on the web, have made technology much more feasible for use. The marketplace for online educational tools has also grown; Apple’s store now boasts more than 80,000 such apps. Interoperability standards are beginning to ease how data from different schools systems and instructional tools are stored and shared. From 2013 to 2015, U.S. K-12 schools purchased more than 23 million devices, according to Futuresource Consulting.

“In economics, things take longer to happen than you think they will,” Rudiger Dornbusch, the late MIT economics professor, once said, “and then they happen faster than you thought they could.”

Today’s education technology has matured after decades of fits and starts. Improved bandwidth, cloud computing power and distribution channels such as app stores, among other infrastructural improvements, have helped developers make technologies more accessible, affordable and, most importantly, reliable for students and teachers to use.

Yet the question remains: What will technology do once it is in the hands of teachers and students? To better understand the interplay of new technologies and instructional practices, we’ll explore how edtech tools in three popular categories—math, English Language Arts and assessment—have evolved over time, how they reflect the pedagogical trends and then what this means in the context of Puentedura’s framework.
PRODUCT PROFILES: WHAT TODAY’S TOOLS OFFER

How have today’s technologies evolved to help children develop math and reading abilities—the two core competencies that typically reflect how well they’re learning in school? And how do new tools allow them to demonstrate what they know, aside from traditional paper-and-pencil tests?

Math
In Search of the Middle Ground

ELA
Teaching Reading in America

Assessment
In Search of the Middle Ground
Is it more important for kids to memorize math formulas and compute—or understand concepts and create their own approaches to solving problems? Whether students use pencils or iPads, the question has long stirred impassioned discussion among parents, teachers, mathematicians and policymakers. In 2004 University of California, Berkeley math professor, Alan Schoenfeld, described this debate as “Math Wars” that have persisted throughout the 20th century.

Disagreements persist today between “traditionalists” who believe math instruction should focus on calculations and processes, versus “reformers” who want students to develop the logical and conceptual understanding behind math. The “New Math” movement of the 1950s, championed by professional mathematicians, attempted to introduce conceptual thinking, such as the ability to calculate in bases other than 10. (Here is a satirical song by pianist and mathematician Tom Lehrer.) The effort floundered, derided by parents, teachers and mathematicians who lampooned the instruction as overly abstract and conceptual.

A 2007 report from the National Mathematics Advisory Panel, assembled by the U.S. Department of Education, summed up these battles as a struggle over:

“How explicitly children must be taught skills based on formulas or algorithms (fixed, 2 step-by-step procedures for solving math problems) versus a more inquiry-based approach in which students are exposed to real-world problems that help them develop fluency in number sense, reasoning, and problem-solving skills. In this latter approach, computational skills and correct answers are not the primary goals of instruction.”
This polarization is “nonsensical,” Schoenfeld noted. The two approaches are not mutually exclusive. Why can't math instruction embrace both procedural and conceptual knowledge?

The Common Core math standards, released in June 2010, is the latest attempt to find a middle ground. Originally adopted by 46 states, the standards aim to pursue “conceptual understanding, procedural skills and fluency, and application with equal intensity.” Yet some students, parents and teachers have heckled the standards for befuddling homework problems and tests. It seemed not even curriculum developers knew how to translate Common Core math principles into instructional materials. See one example of a math problem gone “viral.” Concerns about “fuzzy math” resurfaced, amplified through social media channels and YouTube.

Yet one fundamental difference between the math wars today and those of a half century ago is that today’s technology—in the form of Google or software such as Wolfram Alpha—can solve nearly any math problem with clicks and swipes. This ability will influence what teachers teach and how those subjects are taught.

“Math has been liberated from calculating,” proclaims Conrad Wolfram, strategic director of Wolfram Research. Computers, he states, can allow students to “experience harder problems [and be] able to play with the math, interact with it, feel it. We want people who can feel the math instinctively.”

**HOW MATH TOOLS EVOLVED**

**From Drilling to Adapting**

The earliest instructional math software didn’t offer much in the form of instruction. In 1965, Stanford University professor Patrick Suppes led one of the first studies on how a text-based computer program could help fourth-grade students achieve basic arithmetic fluency. The program displayed a problem and asked students to input an answer. Correct responses would lead to the next problem, while incorrect ones would prompt a “wrong” message and give students another chance to get the correct answer. If this second attempt was still incorrect, the program would show the correct answer, and repeat the problem to help reinforce the facts.

Credit: Number Munchers (left) and Math Blaster (right)
Decades later, many instructional math software would retain the same “drill-and-kill” approach. This trend was best reflected in the popularity of games such as Number Munchers and Math Blaster in late ’80s and throughout the ’90s, which also incorporated gaming elements such as points and rewards into their drill exercises.

Even so, during the 1960s, when enthusiasm for artificial intelligence was on the rise, university researchers began work on “intelligent tutoring systems” aimed at identifying a student’s knowledge gaps and surfacing relevant hints and practice problems. There were limitations, to be sure; researchers lacked enough fine-grain data for their algorithms to make useful inferences. Yet after decades of research, Carnegie Mellon University researchers released one of the first commercially available K–12 educational software programs, Cognitive Tutor. That was followed a year later with ALEKS, based on the work at researchers at University of California, Irvine. The products use different cognitive architecture models to attempt to deduce what a student knows and doesn’t. (To learn more about what happens inside these engines, check out our EdSurge report on adaptive learning edtech products.)

More recently other “adaptive” math tools use frequent assessments to try to pair appropriate content with learners. When a student answers a question incorrectly, such programs attempt to identify knowledge gaps and surface relevant instructional materials. Some tools, like KnowRe, will provide instructions on how to solve a problem. Others tools reinforce procedural concepts in videos that offer instruction ranging from step-by-step explanations (Khan Academy), to animations (BrainPOP), to real-world scenarios (Mathalicious).

Despite the ability of technology to deduce what students need and provide instruction, developers also recognize that educators must still retain their instructional role. DreamBox, which sells adaptive math software, recently added features to allow teachers more control over content assignment. “While we are still really focused on building student agency, we also want to ensure that we build teacher agency,” says Dreambox Chief Executive Officer and President Jessie Woolley-Wilson.

‘SEEING’ MATH BEYOND SYMBOLS

Math is often represented by symbols (+ − x ÷), but technology today allows developers to eschew traditional notations to allow students to explore math in more visual and creative ways. There is supporting evidence: Researchers have observed Brazilian children street vendors performing complex arithmetic calculations through transactions (“street mathematics”) but struggling when presented with the same problems on a formal written test.
“We can make every mathematical idea as visual as it is numeric,” says Stanford education professor and YouCubed co-founder Jo Boaler. Boaler has studied neurobiological research on how solving math problems stimulates areas of the brain associated with visual processing.

“Everyone uses visual pathways when we work on mathematics and we all need to develop the visual areas of our brains,” she wrote in a recent report.

In the 1980s, tools including Geometer’s Sketchpad offered learners ways to explore math visually through interactive graphs. Today’s tools allow teachers to create their own activities and for students to share their work. Desmos, a browser-based HTML5 graphing calculator, invites them to explore and share art made with math equations. “There’s enormous value in allowing students to create, estimate, visualize and generalize,” says Dan Meyer, chief academic officer at Desmos, “but a lot of math software today just allows them to calculate.”

Educational game developers have also found ways to introduce mathematical concepts without using symbols. ST Math (the two letters stand for spatial–temporal), uses puzzles to introduce Pre–K–12 math concepts without explicit language instruction or symbolic notations. Another popular game, DragonBox, lets students practice algebra without any notations. BrainQuake aims to teach number sense through puzzles involving spinning wheels.

Although games can make math more engaging, students may need support from teachers to apply skills learned from the game to schoolwork and tests. “One of the ways video games can be extremely powerful,” says Keith Devlin, a Stanford professor, co-founder and chief scientist of Brainquake and NPR’s “Math Guy,” “is that when a kid has beat a game, he or she may have greater confidence to master symbolic math. I think a two—step approach—video game and teacher—can be key in helping students who hate math get up to speed.”
Like math, literacy has had its own "Reading Wars" (or "Great Debate") throughout the 20th century. Proponents of a phonics-based approach believed students should learn to decode the meaning of a word by sounding out letters. But in English, not all words sound the way they are spelled, and different words may sound alike. Alternatively, other researchers and educators advocate a “whole language” approach that incorporates reading and writing, along with speaking and listening.

The back-and-forth debate eventually reached policymakers, who were alarmed by the 1983 report, “A Nation at Risk,” that charged that American students were woefully underprepared compared to their international peers. In California, poor results on the 1992 and 1994 National Assessment of Educational Progress reading test—more than half of fourth-grade students were reading below grade level—fueled critiques of the state’s whole-language approach.

In 1997, the National Institute of Child Health and Human Development convened a national panel of literacy researchers and educators to evaluate and recommend guidelines. Published in 2000, the report recommended a mix of two approaches, stating that “systematic phonics instruction should be integrated with other reading instruction to create a balanced reading program.” The authors added:

... literacy acquisition is a complex process for which there is no single key to success. Teaching phonemic awareness does not ensure that children will learn to read and write. Many competencies must be acquired for this to happen.

The findings allayed some of the debate over how to teach reading. But the Common Core reading standards raised new questions around
what reading materials should be taught, including nonfiction and informational texts that “highlight the growing complexity of the texts students must read to be ready for the demands of college, career, and life.” The standards also aimed to set a higher bar for literacy beyond reading. Students were expected to be able to cite text-specific evidence in argumentative and informational writing.

Yet for all the focus on facts and evidence, the standard writers did not specify what should be read at each grade level. While they offer examples of books appropriate for each grade, states and districts are expected to determine the most appropriate content. In setting high expectations for what students should be able to read, but refraining from offering specific steps to get there, educators wound up left to look for their own resources. This ambiguity has given license to publishers, researchers and entrepreneurs to shape that path.

**HOW ELA TOOLS EVOLVED**

![Graph of Percent of Tools Covering Different Subjects at Various Grade Levels](image-url)

Source: EdSurge

**Tracking Readers**

Digital book collections have long promised to expand the availability of fiction and nonfiction books. But now such tools also offer teachers a more convenient way to track reading than reviewing students’ self-recorded logs. Today’s products offer data dashboards that chronicle how many books were read, how long students spent reading and which vocabulary words students looked up. Often digital texts come embedded with questions written by content experts or, in some cases, created by teachers themselves.

Given the capability of tools to capture information about students’ reading habits, it’s “important for teachers to have frameworks and dashboards to make that data actionable,” says Jim O’Neill, chief product officer at Achieve3000. “By having a sense of whether students are comprehending the text, or how much they’ve read, teachers can provide the appropriate follow-up [support].”
Let’s Lexile

The broad scope of available online reading materials makes a traditional challenge even more front and center: How can teachers identify what texts are most appropriate for students? Figuring out the right level of complexity for every student—including subject matter, text complexity, or other factors—is subjective and, at best, an inexact science. Both educators and developers have turned to reading frameworks that attempt to quantify text difficulty by measures such as word length, word count and average sentence length.

“Almost every major edtech literacy company will report on text complexity in some form,” adds O’Neill. A popular framework used by his company and other adaptive literacy products is the Lexile, which measures readers’ comprehension ability and text difficulty on a scale from below 0L (for beginning readers) to over 2000L (advanced) based on two factors: sentence length and the frequency of “rare” words. Many products today will assign students a Lexile score (based on how they perform on assessments after reading a text) and recommend reading content at the appropriate level. Some companies, such as Newsela and LightSail, present the same content rewritten at different Lexile levels so that students can read and discuss the same story.

Despite the popularity of Lexile levels, some researchers such as Elfrieda Hiebert, a literacy educator and chief executive officer of Text Project, preach caution against relying exclusively on Lexile numbers to find grade-appropriate texts. She has pointed out, for instance, that The Grapes of Wrath, a dense book for most high schoolers, has a lower Lexile score (680L) than the early reader book, Where Do Polar Bears Live? (690L). The former has shorter sentences (with plenty of dialogue) while the latter has longer ones.
Chapter 3: Product Profiles

The Lexile is just one of seven different computer formulas that Common Core standards writers have found to be “reliably and often highly correlated with grade level and student performance-based measures of text difficulty across a variety of text sets and reference measures.” Established companies, including Pearson and Renaissance Learning, have developed alternatives to Lexile. Another effort, the Text Genome Project, which Hiebert is advising, uses machine learning technology to identify and help students learn the 2,500 related word families (such as, help, helpful, helper) that make up the majority of texts they will encounter through high school.

**Nod to Nonfiction**

The Common Core is not the first effort to emphasize nonfiction and informational texts. In 2009, the National Assessment of Educational Progress (NAEP) called for a 50–50 split between fiction and nonfiction reading materials for fourth-grade students, and a 30–70 ratio by twelfth grade. Common Core reinforced that message: A 2015 NAEP survey found that the percentage of fourth-grade teachers who used fiction texts “to a great extent” declined from 63 percent to 53 percent between 2011 and 2015, while the nonfiction rose from 36 to 45 percent over the same period.

![Types of Books Read by 4th Graders](image_url)

Source: National Assessment of Educational Progress
Companies have noted this shift and many offer nonfiction content as a selling point. Achieve3000, LightSail Education and Newsela employ both writers who will produce their own nonfiction articles and syndicated stories from news publishers that they rewrite at different Lexile levels. Such content also comes embedded with formative assessments to gauge students’ reading comprehension. Other startups, such as Listenwise, offer audio clips from public radio stations, along with comprehension and discussion questions, to help students build literacy through online listening activities.

**Writing to Read**

“Writing about a text should enhance comprehension because it provides students with a tool for visibly and permanently recording, connecting, analyzing, personalizing, and manipulating key ideas in text.”

So state the authors of “Writing to Read,” a meta-analysis published in 2010 of 50 years’ worth of studies on the effectiveness of writing practices on students’ reading grades. The need for this skill only grows in the internet era, as students need to be able to comprehend, assess, organize and communicate information from a variety of sources.

According to the Common Core writing standards, students are expected to start writing online by fourth grade, and by seventh grade should be able to “link to and cite sources as well as to interact and collaborate with others.”

Online writing tools—most notably Google Docs, which the company boasts has more than 50 million education users—allow teachers and students to comment and collaborate in the cloud. NoRedInk and Quill offer interactive writing exercises that let students sharpen their technical writing skills and grammar. Other startups, such as Citelighter and scrible scaffold the research and writing process to help students organize their notes and thoughts. Their progress—words written, sources cited, annotations—are captured on a dashboard that teachers can monitor.

Other tools are more ambitious. Turnitin and WriteLab use natural language processing to provide automatic feedback beyond the typical spelling and grammar checks and attempts to point out errors in logic and clarity. (Our test run with these tools, however, found questionable feedback, suggesting they still need fine-tuning. There are still some core instructional tasks, it turns out, that technology has yet to perfect.)
Chapter 3: Product Profiles

“Through embedded assessments, educators can see evidence of students’ thinking during the learning process and provide near real-time feedback through learning dashboards so they can take action in the moment.”

2016 National Education Technology Plan

Students find tests stressful for good reason. Results not only evaluate what they have learned, but can be used to determine whether they graduate or get into college. Such assessments are “summative” in that they aim to evaluate what a student has learned at the conclusion of a class. In 2002 when the U.S. government tied school funding to student outcomes through the No Child Left Behind law, tests became stressful for educators as well.

With so much at stake, testing became a top priority in many classrooms. A 2015 survey of 66 districts by the Council of Great City Schools found that U.S. students on average took eight standardized tests every year—which means by the time they graduated high school, they would have taken roughly 112 such tests. Testing fever was followed by fatigue; nearly two-thirds of parents in a Gallup poll released that year said there was too much emphasis on testing.

But tests need not be so punitive. For decades, education researchers have argued that tests can be used during—not after—the learning process. In 1968, educational psychologist Benjamin Bloom argued that “formative” assessments could diagnose what a student knew, enabling teachers to adjust their instruction or provide remediation. Students could also use these results to better understand and reflect on what they know.

To check for understanding, teachers can use formative assessments in the form of short quizzes delivered at the beginning or end of class, journal writing and group presentations. (Here are 56 examples.)

“There’s no emotional stress associated with formative assessments,” said Cory Reid, chief executive officer of MasteryConnect. “They help teachers engage with students during the learning process.”

In moderation, smart strategic tests can help us measure our kids’ progress in schools [and] can help them learn,” President Obama said in a video address.

“Tests should enhance teaching and learning,” Obama continued. In December 2015, he signed the Every Student Succeeds Act, allowing states more flexibility in determining how and what they could use to assess students. By doing so, the government opened the door to let states decide what works best for their schools.
Summative tests still remain, but the industry has shifted its focus to embedding tests to make them an integral part of the teaching and learning process. In addition academic achievement is no longer the primary focus; technologists are attempting to quantify non-cognitive factors, including student behavior and school culture, all of which impacts how students learn.

**HOW ASSESSMENT TOOLS EVOLVED**

**The Many Forms of Formative Tests**

In the 1970s, Scantron Corporation offered one of the most popular and commercially successful technologies for doing formative and summative tests: bubble sheets that students would fill out with #2 pencils that could be automatically graded. A couple decades later, “clickers”—devices with buttons that transmit responses to a computer—offered an even quicker way for teachers and students to get feedback on multiple-choice questions.

Today, web-based and mobile apps can deliver formative assessments and results cheaper and more efficiently. Smartphones and web browsers have become the new clicker to deliver instantaneous feedback. In classrooms where not every student has a computer or a phone, some teachers use apps to snap photos of a printed answer sheet and immediately record grades. And as teachers use more online materials, there are also tools that allow them to overlay questions on text, audio or video resources available on the internet.

Student responses from formative assessment tools can be tied to a teacher’s lesson plans or a school’s academic standards. This information can help teachers pinpoint specific areas where students are struggling and provide targeted support.

Faster feedback also means that assessments can be given even as lessons are going on. “If you know what a student knows when they know it, that informs your instruction as a teacher,” says Reid. That data can “enrich your teaching and help change a student’s path or trajectory.”
Beyond Multiple Choice
The Common Core tests, which many students take on computers, introduced “technology-enhanced items” (TEIs). These allow students to drag-and-drop content, reorder their answers and highlight or select a hotspot to answer questions. Such interactive questions, according to the U.S. Department of Education’s 2016 National Education Technology Plan, “allow students to demonstrate more complex thinking and share their understanding of material in a way that was previously difficult to assess using traditional means,” namely through multiple choice exams.

A well-designed TEI should let educators “get as much information from how students answer the question in order to learn whether they have grasped the concept or have certain misconceptions,” according to Madhu Narasa, CEO of Edulastic. His company offers a platform that allows educators to create TEIs for formative assessments and helps students prepare for Common Core testing. Another startup, Learnosity, licenses authoring tools to publishers and testing organizations to create question items.

Yet teachers and students need training to use TEIs. And the latest TEIs may not always work on older web browsers and devices. One early version of the Common Core math test developed by Smarter Balanced Assessment Consortium featured TEIs that even adults found difficult to use. And, while TEIs offer more interactivity, their effectiveness in measuring student learning remains unproven. A 2015 report from Measured Progress, another developer of Common Core tests, suggested “there is not broad evidence of the validity of inference made by TEIs and the ability of TEIs to provide improved measurement. Without such research, there is no way to ensure that TEIs can effectively inform, guide, and improve the educational process.”

**Show Me Your Work**

Tests are not the only way for students to demonstrate understanding. Through hands-on projects, students can demonstrate both cognitive and noncognitive skills along with interdisciplinary knowledge. A science fair project, for example, can offer insights into students’ command of science and writing, along with their communication, creativity and collaboration skills.

The internet brought powerful media creation tools—along with cloud-based storage—into classrooms, allowing students to create online. Companies such as FreshGrade offer digital portfolio tools that aim to help students document and showcase their skills and knowledge through projects and multimedia creations in addition to homework and quizzes. Through digital collections of essays, photos, audio clips and videos, students can demonstrate their learning through different mediums.

**Games as Test**

What can games like SimCity, Plants vs. Zombies and World of Warcraft tell us about problem-solving skills? A growing community of researchers, including Arizona State University professor James Paul Gee, argue that well-designed games can integrate assessment, learning and feedback in a way that engages learners to complete challenges. “Finishing a well-designed and challenging game is the test itself,” he wrote in 2013.
GlassLab, a nonprofit that studies and designs educational games, has developed tools to infer mastery of learning objectives from gameplay data. These tests are sometimes called “stealth assessments,” as the questions are directly embedded into the game. The group has described at length how psychometrics, the science of measuring mental processes, can help game designers “create probability models that connect students’ performance in particular game situations to their skills, knowledge, identities, and values, both at a moment in time and as they change over time.”

A 2014 review of 69 research studies on the effectiveness of games by research group, SRI International, offers supporting evidence that digital game interventions are more effective than non-game interventions in improving student performance. But other studies offer a mixed picture. A study led by Carnegie Mellon University researchers on a popular algebra game, Dragonbox, found that “the learning that happens in the game does not transfer out of the game, at least not to the standard equation solving format.” Similar to the Brazilian “street math” kids (see math profile), these students are capable of solving math problems—just not on a traditional paper exam.

Noncognitive Skills

Educators and researchers also believe that non-cognitive skills—including self-control, perseverance and growth mindset—can deeply influence students’ academic outcomes. In 2016, eight states announced plans to work with the nonprofit CASEL (Collaborative for Academic, Social, and Emotional Learning) to create and implement standards around how social and emotional skills can be introduced into classroom instruction.

Today, developers are seeking ways to quantify factors such as student behavior and school climate. Tools such as Kickboard and LiveSchool record, track and measure student behavior. Panorama Education lets educators run surveys to learn how students, families and staff feel about topics such as school safety, family engagement and staff leadership. Tools like these expand the use of assessments beyond simply measuring student performance on specific subjects and cognitive tasks.
SAMR: HOW WILL WE KNOW IF TECHNOLOGY WILL MAKE A DIFFERENCE?

Will shiny gadgets help educators do the same thing—or enable new modes of teaching and learning? Here’s a popular framework to help us understand how technology can change practice.

No matter what features are built into an edtech product, the technology is unlikely to impact learning if it’s misapplied. “Putting technology on top of traditional teaching will not improve traditional teaching,” said Andreas Schleicher, director for the Directorate of Education and Skills at the Organisation for Economic Co-operation and Development, in an interview with EdSurge earlier this year.

A 2015 report by the OECD found “no appreciable improvements in student achievement in reading, mathematics, or science in the countries that had invested heavily in ICT for education.” Noted Schleicher:

“The reality is that technology is very poorly used. Students sit in a class, copy and paste material from Google. This is not going to help them to learn better.”

But there are several corollaries. First, not every traditional teaching practice needs to be reinvented—some are working well. Second, not every technology can “revolutionize” learning. And third, to get powerful results, the kind that drive student learning, technology must be aligned with practice in purposeful ways.

But first, educators need to know which is which.

As a teaching fellow at Harvard University in the late 1980s, Ruben Puentedura started paying attention to how educators used tools
in the classroom. Later, as the director of Bennington College’s New Media Center, he further explored how faculty and students integrated technology and instruction to reach the best learning outcomes. His efforts led him to start a consulting firm, Hippasus, that works with schools and districts to adopt technology.

In 2002, he published the SAMR framework to help educators think about how to integrate instructional practice and technology to reach the best outcomes for students. SAMR defines how technology impacts the teaching and learning process in four stages:

<table>
<thead>
<tr>
<th>S</th>
<th>A</th>
<th>M</th>
<th>R</th>
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</thead>
<tbody>
<tr>
<td><strong>Substitution</strong>&lt;br&gt; Tech acts as a direct tool substitute, with no functional change in instruction</td>
<td><strong>Augmentation</strong>&lt;br&gt; Tech acts as a direct tool substitute, with functional improvement</td>
<td><strong>Modification</strong>&lt;br&gt; Tech allows for a significant task design</td>
<td><strong>Redefinition</strong>&lt;br&gt; Tech allows for the creation of new tasks, previously inconceivable</td>
</tr>
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</table>

The SAMR framework is centered around the premise that technology, when used strategically and appropriately, has the potential to transform learning and improve student outcomes. Puentedura has also applied this framework to existing education research to suggest that greater student outcomes can occur when edtech tools are used at the later stages of the framework (modification and redefinition).

**Preparing to use SAMR**

To start, Puentedura says teachers must be clear about what outcome they want for their students. “The purpose, the goals of teachers, schools and students, are the key drivers in how technology is used,” he says.

“What is it that you see your students not doing that you’d like them to do? What type of knowledge would you like them to explore that they’re not exploring? What type of opportunities for new visions, new ideas, new developments would you like to pick up on?”

Additionally, it is important for teachers to identify how technology is currently used in the classroom, as a reference point for moving through the stages of SAMR. This requires an understanding of available resources—not just the technology that students can access, but also time and support required to use the tools well.

New technologies are often first used at the substitution level, especially when teachers and students are unfamiliar with the tools. This level of usage has its merits, even if it may not radically change instructional practices. Reading digital textbooks may, in the long run, be cheaper for schools than ordering new print versions every time the content is updated. Having students compose essays using a cloud-based word processor makes it easier for teachers to track and grade assignments.
The SAMR framework is not just about technology in and of itself, but rather what educators and students can use the tech to accomplish. “Changes in the tools themselves matter less than how you’re thinking about the learning objectives,” explains Jim Beeler, Chief Learning Officer at Digital Promise, who has helped schools rollout programs where every student has a digital device (called 1:1 programs). After all, the same tool can be used in different stages. A digital textbook, for example, can used as a substitute for print if all students do is read, highlight and annotate. But if the textbook includes speech synthesis or audio features, the students’ reading experience is augmented through the addition of the auditory mode of learning.

A PRIMER ON SAMR

Here are some guiding questions and a familiar type of assignment as an example—sharing reflections on a reading assignment—to better illustrate the SAMR framework in practice.

SAMR Misconceptions

Although Puentedura’s studies suggest that greater student outcomes can be achieved at the redefinition level, he warns against the notion that every teacher should aspire to use technology to redefine their practice. “Are you going to get more impact upon student outcomes from using technology at the R level than at the S level? Sure,” he says, “but that doesn’t mean that there aren’t many, in fact, probably a large majority of technology uses that work just fine at the S and A level.”

1. SAMR is just about using technology

SAMR is designed to analyze the intersection of technology and instructional practices. The framework is designed to focus on the changes that technology enables—not the technology itself. Make no mistake—educators and students are the ones that make learning happen, not the technology.

2. It is better to be further “up” the framework

Not every instructional practice needs to be redefined; as Puentedura points out, often “substitution” can be the right form of change. It can be exhausting and inappropriate for teachers and students to constantly teach and learn at the modification and redefinition levels. Educators need to find the right mix of activities that are appropriate for their learning objectives and employ technology in the way that best fits those goals.

3. Change is always necessary

Don’t change just for the sake of change. SAMR—or any other framework—may offer a way to describe changes in technology usage. But that does not mean that teachers should continually strive to change their practices. Teachers must have a clear vision of their instructional goals and desired student outcomes before devising ways to implement new tools in a classroom.
CASE STUDIES: FROM TECHNOLOGY TO PRACTICE

Technology can make a difference. Here are a dozen profiles of how educators from across the country have used tools to support instructional needs and transform teaching practices.

There are more than 2,000 tools in the EdSurge Product Index and many more tales to be told about how they can support teaching and learning. (Here’s one example of how teachers use a digital assessment tool, FreshGrade.) If you’re interested in sharing your personal experiences using specific tools, Submit a Case Study.
Chapter 3: SAMR

A FREE TOOL TO KEEP A FINGER ON THE PULSE OF STUDENT LEARNING

PROBLEM
After spending seven years teaching in high school, Jones earned her Ed.D. in math education from Teachers College, Columbia University in 2011. She returned to the classroom charged up about helping kids overcome their fear of math. She sought ways to resolve pain points in her classroom but found tracking every student’s learning and providing real time support was hard.

Jones studied the impact of gaming on math and on building students’ confidence. She understood how technology could be impactful in the classroom and wanted to put into practice all that she learned, starting with optimizing small daily activities.

PREVIOUS SOLUTIONS
Jones used to go in front of the class and explain the day’s lesson using direct instruction with manipulatives and a whiteboard. However, as soon as she erased the board, her explanation vanished, too. Manipulatives were expensive; she needed dozens of copies for all her students (this year, she has about 80). To nudge kids to participate in class, Jones would ask her students to raise their hands—some would get heard, some would not. And to see whether or not her students were following her explanations, Jones spent hours grading worksheets.

TECHNOLOGY
All students in Jones’ school have iPads and Kuno tablets. She turned to Classflow, an app that digitizes classroom workflows, in January 2014. Jones used it to create lessons, assessments and assignments. The tool also offers a polling feature, which she could use to probe students during class to capture a real-time sense of how kids are making sense of the subject just taught.

CHANGE
Both Jones and her students used Classflow. Jones created and shared her lessons with the tool. Students took notes and saved them also with the software.

The tool also helped improve class participation. Because the whole class could see every student’s responses in real time, every learner was heard and seen. When Jones taught equations, for instance, she could write and send a question to students and see their responses immediately. These features helped her manage her instruction: “I can make it as rigorous as I want and the kids are still with me every step of the way because they are stimulated. It’s a constant flow. There is no dead space in my class,” Jones says.

WHY SUBSTITUTION
Jones used Classflow to optimize activities—delivering lessons and exercises, taking notes, asking questions—that were already a part of her practice. She gained more participative students and a much better sense of her students’ learning.

Valerie Camille Jones
OCCUPATION
Middle school math teacher at The Ron Clark Academy in Atlanta, GA
TEACHING EXPERIENCE
16 years
TECHNOLOGY
Classflow
TWITTER
@drvcjones
READ ALL YOU WANT

PROBLEM
Ellen Dorr’s school district needed to provide students with adequate access to non-fiction texts at a variety of Lexile levels. Dorr also wanted to help students, particularly English-language learners, to build their fluency muscles.

PREVIOUS SOLUTIONS
Previously, the district purchased primarily physical books. But books had become expensive and the district’s ability to buy new books, especially for nonfiction texts, lagged the demand for them by teachers and students.

TECHNOLOGY
During the 2016-2017 school year, the district will supplement classroom libraries with digital libraries using myON reader, a platform that offers more than 10,000+ online books. Each title is digitally enhanced: the system highlights the text as it is read, and students have the ability to look up definitions. The platform recommends books based on the students’ interests in categories such as fiction, non-fiction and different subject matters.

CHANGE
“We know that this change isn’t about technology; it’s about providing students access to text,” explains Dorr. As Renton School District starts to use digital libraries this school year, educators expect to see students spending more time reading appropriately leveled texts, particularly non-fiction. myOn will support the district’s model for balanced literacy, especially during reader’s workshops. Six elementary schools will participate in the pilot and about 3,000 students will be affected; and much care has been given to implement the change effectively, including a thoughtful selection process for the technology and pilot schools, how usage will be supported and how results will be determined.

WHY SUBSTITUTION
myON will replace traditional textbooks and enable students to read texts at a variety of levels. At the same time, the tool will provide students with access to many more books than a classroom or school library can provide. Although Dorr plans to use myON as a substitute for paper books, she expects that other teachers may also use the tool to augment their practice, particularly by encouraging students to use myON’s audio features.
Chapter 3: SAMR

FORMS FOR FORMATIVE ASSESSMENTS

PROBLEM
Last fall, Haage was looking for a way to assess students that was less stressful than traditional pencil-based assessments. She knew they were already comfortable taking tests online.

PREVIOUS SOLUTIONS
To assess students, Haage typically printed out test handouts that all students would complete at the same time.

TECHNOLOGY
Last school year, Haage used Google Forms to create and deliver quizzes and tests when she was doing an in-class flipped classroom after state testing was over. Google Forms was one part of a “padlet,” a collaborative virtual sticky note app, which she had used when she was teaching area and perimeter. The padlet contained an instructional video from Mathantics.com, the Google Form assessment, and a game to play to practice the concept.

CHANGE
The activities added to the padlet allow students to work at their own pace through the content, practice and assessment. Those that do not understand the concept can go back and watch the video again before taking the assessment. The data from Google Forms helped Haage determine whether students are learning and whether she needs to teach the lesson differently or introduce different activities in the classroom. Using Google Forms, Haage has found that she is better able to assess her students, “because students don’t feel the same anxiety and pressure that they associate with a formal test,” says Haage. “Assessing students in this way masks the fact that they’re being assessed at all.”

WHY SUBSTITUTION
Haage used Google Forms to replace the paper and pencil tests, and as a result she’s able to better understand how well her students grasp the materials. She’s also seen students more engaged—and less stressed—by formative assessments.
Chapter 3: SAMR

ADDRESSING THE GAPS OF ALL LEARNERS

PROBLEM
She had been teaching math since 2005, but for the past four years Pam Baack felt she was increasingly struggling to address the needs of all her students. Her strategy of having them work in groups was successful as long as all students had a strong foundation in the concepts. “For division, fraction and decimals, the process did not work because each student was processing the content at his or her own pace and it was difficult to support different needs at the same time,” Baack recalls.

PREVIOUS SOLUTIONS
Using the printed version of the *Everyday Mathematics* curriculum, Baack would begin each class by having students review key objectives. They then moved into doing individual workbook exercises even as Baack worked with small groups of students. “The only time I could target individual kids was during worksheet time,” Baack says. “It worked, but not as well as it could have.” According to Baack, she had to go back and forth between supporting group work and individual students who needed help with the workbook.

TECHNOLOGY
About four years ago, Baack cobbled together eight desktop computers, rescuing unused computers from other classrooms. Baack registered her students for *AdaptedMind* (an adaptive math assessment, videos, and practice tool) and set up a station rotation model, a blended learning program in which students rotate between stations that support different activities.

CHANGE
“That was my first step into what we know now as ‘blended,’” says Baack. She used AdaptedMind as a supplement to give students struggling with particular concepts extra practice. It made a difference: “I was able to group students based on pre- and post-assessments and saw that small groups were making movement each week,” she says.

But the program didn’t provide enough data for her to pinpoint the exact concepts that students struggled with. During group activities, she developed her own checks for understanding and adopted a new math platform, *Zearn*. These days, Baack’s classroom has students working in a self-paced environment, with half of class time spent in small group instruction and practice, and the other half using Zearn.

WHY AUGMENTATION
By adopting AdaptedMind (and later Zearn), Baack used tools that were able to assess each student’s gaps in understanding and provide additional support—something that she did not have time to do with paper-and-pen worksheets.
DITCH THE PAPER. LET'S MAKE A PODCAST!

PROBLEM
Four years ago when she was teaching ELA at a nearby school, Rachel Pierson wanted her sixth graders to exercise skills like creativity and collaboration while reading the novel, *Hatchet*, by Gary Paulsen. “I really wanted to avoid the paper and pencil test,” she recalls.

PREVIOUS SOLUTIONS
In her first years as an ELA teacher, Pierson used multiple-page written tests to measure whether or not her students understood a book. She wanted to stimulate students’ critical reflection about every aspect of the novel. While this approach allowed students to express their opinions and develop their written skills, it was time-consuming for her to grade. “I tried to be innovative in allowing them to draw pictures [in the test],” Pierson says.

TECHNOLOGY
In 2012, Pierson’s school piloted a 1:1 program with Chromebooks. “I wanted to show other teachers and the principal that having these devices could transform the way we teach and allow the students to be more creative while they learn.” She started using Google tools like Google Docs and later found out about Vocaroo, a web-based simple podcast recorder.

CHANGE
With Chromebooks, Google Docs and Vocaroo in hand, Pierson devised a fresh assignment: Students would play journalists and “interview” the main character in *Hatchet* about how he had changed over the course of the book. Students gathered specific statements from the text to support their story, which they drafted in Google Docs. They worked in pairs, each team member editing one another and then submitting the document for Pierson’s feedback. Afterward, the students recorded themselves with Vocaroo, telling the story of *Hatchet*.

WHY AUGMENTATION
The addition of Google Doc and Vocaroo helped Pierson turned what was a static assignment—a paper-and-pen test—into a collaborative, multimedia experience that encouraged students to tell a story in a creative way through media such as podcasts.

Rachel J. Pierson

OCCUPATION
6th grade STEM teacher at Janesville-Waldorf-Pemberton Elementary, Janesville, MN

TEACHING EXPERIENCE
12 years

TECHNOLOGY
Chromebooks
Google Docs
Vocaroo

TWITTER
@RPiersonEdu
Chapter 3: SAMR

CUSTOM-BUILT QUIZZES FOR REAL-TIME INTERVENTION

PROBLEM
In fall of 2009, Leadership Public Schools (LPS) started looking for tools that would let teachers intervene more quickly when students did not understand concepts and could help increase student engagement in the learning process overall.

PREVIOUS SOLUTIONS
Using donated physical “clickers,” LPS piloted a new approach to formative assessment. Students used the devices to pick an answer to a poll shared with the class. The system had some early success—teachers were able to more accurately determine how the entire class performed. But using clickers had challenges, too: It was an expensive approach and only gave teachers insights on the overall class performance—not on how individual students were doing and not in real-time. Additionally, students could only press specific buttons and letters and could not give more detailed responses.

TECHNOLOGY
After further exploring the clicker and other web-based polling options, LPS decided to build its own solution, which it dubbed ExitTicket, a student response software that allowed teachers to create and share different types of assessment questions, aligned to specific learning standards. Teachers had access to the responses immediately and could adjust the course of a lesson, identifying when individual, small group or whole class intervention was required, and track student performance over time. Students were able to take ownership of their learning, correcting mistakes in real-time and seeing their progress.

CHANGE
“Like many tools, ExitTicket can be used in different ways. This was intentional,” explains Fauteux. One common use of the tool is when teachers are reviewing concepts from the homework. Instead of covering every question, the teacher can create quizzes about the covered concepts and focus on discussing the issues that kids struggled with. By zooming in on the challenging homework, Leadership teachers reduced by half the time they spent reviewing homework.

Fauteux’s team measured ExitTicket’s impact on learning outcomes and overall student engagement through regular conversations with students, systematic comparisons between summative and formative assessments, and surveys of students and teachers. They found that grades and standardized test scores were, in fact, going up, and students and teachers overwhelmingly reported “greater enjoyment of the learning process, excitement, accountability, and agency,” Fauteux says. The tool enabled a shift from what he calls “direct” to “responsive” instruction, as teachers built lessons based on real-time student data. “It cemented
the use of formative assessment in our network as a norm and accelerated our exploration of personalized and blended learning possibilities," adds Fauteux.

**WHY AUGMENTATION**
By making the homework checking process more efficient, ExitTicket allowed teachers to spend less time going over every question on a homework assignment. Instead they could focus class time on targeted interventions on the questions or concepts students found most challenging.
LEARNING LINEAR EQUATIONS IN ONE WEEK, NOT ONE YEAR

PROBLEM
Year after year, Cicely Jones’ middle school students have struggled with linear equations. Not all of her students have a solid understanding of basic math operations, nor do they easily grasp the level of abstraction behind the topic. Adding to her challenge: All of her students qualify for free and reduced lunch and nearly 30 percent have special needs or show hyperactive behavior.

PREVIOUS SOLUTIONS
To give each student individual attention, Jones would split her class into different groups. While students helped each other solve equations, she would try to help them individually. But there were not enough minutes in each class for Jones to spend adequate time with everyone.

TECHNOLOGY
Jones created a three-phase activity, to be completed over the course of a couple of weeks, using a combination of Explain Everything, Schoology and Google Slides.

CHANGE
The first part was the instruction itself. Jones taught the lesson to the whole class. Then, she recorded her lesson with the app Explain Everything and shared it with her students through Schoology, the school’s learning management system. The kids could repeat the same lesson whenever they wanted. “That helped a lot with my ADHD kids because when they missed something, they could just back up the video,” says Jones.

In the second part, she assigned her students the task of creating three equations: one, as a class, that had one solution; one, each on their own, that had no solution; and one, in small groups, that had infinite solutions. “Creating an equation is a lot harder than solving it. It forced them to work backwards, from the result to the equation,” Jones says.

Finally, for the group project, students collaborated to create new equations, documenting their steps using Google slides and then teaching linear equations to their classmates. Students’ presentations were also shared on Schoology. What once was very a difficult topic suddenly was turned into a source of pride for her students, says Jones, who adds that the exercises boosted their self-awareness and self-esteem.

WHY MODIFICATION
Jones created a set of learning activities that included real time collaboration that would not have been possible without the technologies. By incorporating videos and presentations, she allows students to learn through collaboration and creative tasks—and no longer needs to have as much one-on-one time with every student.

Cicely Jones

OCCUPATION
8th grade teacher at N. R. Burger Middle School, Hattiesburg, MS

TEACHING EXPERIENCE
9 years

TECHNOLOGY
Explain Everything, Schoology, Google Slides

TWITTER
@iamcicelyjones
PROBLEM
Since Rich Perry began teaching in 1997, he’s encouraged every one of his high school English students to keep a reading log, jotting down reflections on their reading assignments all year. Over the years, it became clear to him that their interest would wane by the middle of the school year; students stopped putting much effort into their writing. Perry found he was a little exhausted as well. It would take him five to seven minutes to grade each reflection, and on average, he has 120 students per year. “If all my students did it, we are talking about a week just to get the essays back to them.”

PREVIOUS SOLUTIONS
In hopes of making the assignment more engaging, Perry would ask students to write their reflections from the perspective of a particular character from the assigned book. The twist didn’t help much; students’ energy was still fading and they still had to wait a week before getting Perry’s feedback.

TECHNOLOGY
In 2013, Perry adopted FlipGrid, an app that allows educators and students to record questions and answers as video clips.

CHANGE
Perry used FlipGrid to record and share his questions about the reading assignments with students. Each student would then record and send a 90-second response. Students enjoyed this new way to share their thoughts, and Perry found it easy to give feedback orally instead of writing notes.

One day, Perry accidentally shared one student’s video with others in the class—a gaff that sparked a lively discussion. What once was an individual reflection became a social exercise. After the “gaff”, he decided to use this as a method. Perry says his students have learned to debate different perspectives respectfully and gained lessons in digital safety along the way. “They don’t realize how often they give away stuff online that they shouldn’t be doing,” says Perry.

Perry’s students now also use FlipGrid to submit essay proposals and discuss books during the summer. Students who were shy about speaking have another outlet to express their thoughts. Perry also uses it to “flip” his classroom, posting video questions the night before a lesson.

WHY MODIFICATION
Perry uses FlipGrid both to replace the journalling activity and to weave an element of social interaction into the reading reflection activities. In doing so, Perry turned what was once an individual task into a peer-learning experience.
FORMATIVE ASSESSMENTS ENRICHED WITH DATA

PROBLEM
Sarah Holm and her fellow educators sought tools that could provide data to help teachers better identify and address students’ particular needs. Teachers had to wait months to see the results from standardized tests mandated by the state and district—far too long to help them re-align their practices. Additionally, her school needed tools to help prepare students to take online assessments in time for Common Core testing.

PREVIOUS SOLUTIONS
Holm’s school previously relied on results from mandated, summative assessments.

TECHNOLOGY
Holm’s team turned to assessment management systems and data banks provided by EduSoft and Datawise to conduct formative assessments. Teachers would go into these programs, search by standard and choose from a bank of questions to create their own assessments. “Kids would log into the software to take the assessment, and the software would provide results for the students,” says Holm.

CHANGE
Students would take formative assessments every week, after which educators would gather to discuss results. During these meetings, educators would review how students performed and share strategies for improving outcomes.

Being able to see how students performed on the weekly assessments allowed teachers to pivot their teaching strategies more quickly. Teachers had a better understanding of which students needed more help, and students were aware of their own learning and able to take charge of their progress and goals. But Holm notes that the approach took substantial time and resources; it took almost three years before the staff as a whole felt comfortable with the entire formative assessment process.

WHY MODIFICATION
The use of new technology allowed Holm to deliver assessments more frequently, thus allowing teachers to have a more detailed understanding of student needs and be more responsive.
Chapter 3: SAMR

PLAYLISTS THAT PUT STUDENTS IN CONTROL

PROBLEM
As a math teacher, Jason Appel struggled to provide students with the opportunity to learn at their own pace and in their own style; he spent a lot of time talking to students one-on-one about their specific challenges and successes.

PREVIOUS SOLUTIONS
Appel used to start each class by standing at the front of the classroom to introduce a new topic and then doing a few examples on the board. Students would follow along and try practice problems on their own. “I talked a lot,” recalls Appel.

TECHNOLOGY
Three years ago, Appel started making videos. One year later, he decided to organize them in playlists. Last year was the first time he created playlists using GoFormative for the entire year’s curriculum. Depending on how much progress students have made in a unit, they work on a different playlist.

Playlists include embedded video snippets (made with the program EdPuzzle) and links to practice problems on sites including IXL and Khan Academy. Appel embeds instant feedback into the playlists so students can complete problems and learn immediately whether or not their answer is correct. Additionally, students can indicate in the playlist whether or not they are ready to move on to the next lesson. If not, Appel meets with the student to go over their difficulties. On average, every playlist takes one hour for Appel to build, he estimates.

CHANGE
Now, students control the path and pace of their learning. Each day, students walk into class, grab their Chromebooks and pick up work where they left off. They can choose to work independently, with peers, or with Appel, who offers “mini lessons” for those who are interested. Appel does a lot less talking now, striving to have conversations one-on-one or in small groups. “I was surprised by how much faster and better I got to know my students—as students, but also as people,” reflects Appel. His students are also interacting more with each other.

Sixty-four percent of Appel’s students have said they prefer playlists to a traditional classroom, according to a survey he’s done with his students after implementing the method. Still some of Appel’s students find the model challenging because it places more responsibility on them. “It was sometimes difficult to know whether frustration was due to struggling with content, the model not working well for them, or a little of both,” says Appel.

WHY REDEFINITION
Using playlists, Appel has been able to shift from whole class instruction where all students move at the same pace with the same content, to one in which students can pick the pace and mode of their learning. With GoFormative, Appel is creating a new, student-driven learning environment, something that would have been impossible without technology.

Jason Appel
OCCUPATION
9th and 10th grade math instructor at Barrington High School, Barrington, RI
TEACHING EXPERIENCE
20 years
TECHNOLOGY
GoFormative
TWITTER
@jason_appel
TAKING READING ASSIGNMENTS TO THE NEXT LEVEL

PROBLEM
For the 2014–2015 school year, Davis was looking for ways to make writing a fresh and different experience for her special education ELA class, while still focusing on Common Core objectives such as conducting short research projects and analyzing ideas. “My students struggle with reading and writing and are not necessarily really motivated to work on these topics,” says Davis.

PREVIOUS SOLUTIONS
To get students engaged in writing, speaking and listening, Davis traditionally relied on pen-and-paper essays and class discussions.

TECHNOLOGY
Davis’ class has had iPads since 2012. In 2013, she purchased iMovie, a video-editing app, and in 2015 she started to work with iMotion, another video editing app. Thanks to a DonorsChoose grant, the class also had several iPad mounts and tripods, which allowed for professional style filming.

CHANGE
Davis changed the assignment from an essay into a project. Students worked in groups and chose a community they wanted to help and social problem that they wanted to address. They were responsible for creating a print piece and video public service announcement to share their work about making a difference in their community with other classes.

Not only were Davis’ students more engaged by these fun, project-based learning activities, they also built needed skills in writing and speaking and listening. Her students experienced the most growth of any students in her school on the end of year exam and, for that reason, Davis received a written recognition from her school district.

WHY REDEFINITION
Instead of writing individual assignments, the technology enabled Davis to redefine the task completely: Students were able to create more collaborative multimedia projects as well as engaging print pieces. These projects gave students a sense of creative agency and opportunities to work with their peers.
FROM PAPER AND PENCIL TO REAL WORLD ASSESSMENT

PROBLEM
In the fall of 2013, Linane sought new ways to assess students that could better reflect their understanding of content. Students struggled with the traditional multiple-choice and open-ended tests, even though Linane knew that many were studying hard.

PREVIOUS SOLUTIONS
Linane used multiple choice tests, vocabulary quizzes and other traditional forms of assessment to measure student growth.

TECHNOLOGY
Using Google Slides, Google Earth Tours, Infogr.am, PowToon and other creation tools, Linane created a diverse set of project-based assessments, starting in the fall of 2014.

CHANGE
This past May, instead of assigning the usual essay to wrap up a history unit on communism, Linane split his students into small groups to design cartoons about the topic using Powtoon, a platform for creating animated videos and presentations. “And what they made was amazing,” he says.

Since Linane started doing projects/mastery learning in the fall of 2014, each lesson in his class culminates with a final student project or performance. The intent is to help students explicitly explore how current events are connected to issues from the past. Linane has found that this approach has helped him rethink assessments in three ways: First, because he uses a set of standards, he can measure learning in different mediums. Second, “it’s a lot more fun for the students and myself!” And third, he says, students are gaining exposure to new skills and media.

WHY REDEFINITION
By shifting to project-based assessments, Linane redefined not just how students were assessed (with projects, as opposed to traditional tests), but also what they were learning. By building and creating projects, students acquired new skills. And by drawing connections between history and current events, the projects became more relevant and authentic.
CONCLUSION

Technology is often conflated with innovation. Yet tools are just part of the equation. Innovation entails humans changing behavior.

In education, technological improvements—in the form of faster broadband, devices or smarter data analytics—must be commensurate with the desire to refine and transform existing practices. What these changes look like is unsettled, but technology allows teachers and students to explore different paths.

Well-designed tools can help educators realize the educational “best practices” put forth decades ago by researchers like Benjamin Bloom. Data from formative assessments can give teachers better insights into what each learner needs and so enable instructors to change strategies. Games and online collaborative projects allow educators to teach in ways that researchers believe can better engage students.

**The most useful educational tools are also flexible. Teachers are adapting media and productivity software for purposes beyond what they were designed for.**

After all, what a math class needs may not be online adaptive curriculum, but rather creative tools that allow students to engage and express knowledge in new ways.

Changing ingrained habits and codified practices requires patience. Not all lectures, lesson plans, group projects or homework demand to be uprooted. As our case studies above show, some teachers use technology to do the same tasks more efficiently. Others are creating entirely new activities that transform learning from a solo to social experience.

Whether teachers reinforce or redefine instructional practices with technology partly depends on their environment. Do they have the training to implement new tools? How can schools support teachers in not just experimenting with new methods of teaching and learning—but in scaling these practices across the campus and district? How can these changes make education opportunities more equitable? These questions will help frame the focus of the next chapter. As classrooms change, so do schools.
The EdSurge team interviewed dozens of teachers, administrators, professors and company executives throughout the course of this project. Their perspectives helped to inform follow-up research on the development of edtech products through published surveys, books, journal articles and policy papers.

We also used our own proprietary database of education technology products to inform our research and create the graphs that highlight the different topics covered by math and English Language Arts products.

To create the case studies, we used an online survey to invite educators to submit stories about their use of education technology tools. We also reached out to teachers on Twitter and on our Facebook teacher community. We aim to reflect a diversity of perspectives, experience and geography through these profiles.

Among the 12 teachers whose stories we profiled in this chapter, we have educators from 12 different U.S. states; who are from and serve students from different ethnicities and social–economic levels; who have from nine to 32 years of classroom experience, and who teach kindergarten, elementary, middle, high school and also educators who are now working in the administrative level.

Please reach out to feedback@edsurge.com if you are interested in being part of future research projects or have any questions.

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