EDUCATION WEEK
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SPOTLIGHT

Jessica Kourkounis for Education Week

While some 2nd graders at Pennsylvania's Belmont Hills Elementary participate in a group activity with an instructional specialist, a smiling Hunter Levy and others work independently on laptops, and teacher Laura Donnelly circulates around the classroom.

DIGITAL MATH INSTRUCTION

EDITOR'S NOTE

Rapid changes in technology have inspired schools to adopt digital tools in the classroom. In this Spotlight, learn how educators are using technology to personalize instruction, facilitate hands-on learning, and boost student engagement in math.

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Published June 11, 2015, in Education Week's Technology Counts Report 2015

Districts Put Open Ed. Resources to Work

Two school systems weigh impact of efforts

By Sean Cavanagh

A growing number of educators and policymakers are being drawn to open educational resources, convinced that the free, malleable, and shareable academic content offers advantages that traditional commercial materials cannot match.

Backers of open resources, many of which are housed online, say they can help schools save money on the costs of instructional materials and build greater collaboration and confidence among teachers as they use and refine that content.

Many districts making the switch from commercial to open resources, however, are still in the nascent stages of that transition. Only now are the practical benefits—and potentially substantial upfront costs—coming into focus.

Momentum in States

Across the country, attempts to nurture and sustain open resources for use in districts have been supported by philanthropies, nonprofits, and universities. State policymakers seem to be keenly interested: 26 states are promoting open educational resources in some form, and 18 states have taken steps to share them with districts, according to a report released last year by the Council of Chief State School Officers.

One of those states is Washington, where the legislature three years ago directed the state's education agency to create and vet a library of open materials, which today includes about 60 resources in English/language arts and 24 in mathematics.

In Washington state, "you have a lot of districts taking this out of the 'this-sounds-like-a-good-idea' phase to 'what is this really going to look like when we put this together?'" said Barbara Soots, the open educational resources manager for the digital learning department within Washington state's office of the superintendent of public instruction.

Two such districts, Bethel and Grandview both pursued open resources in large part because they were not satisfied that commercial curricula were closely aligned with the common core. They called on their teachers, and other content experts, to help them find the open resources that hit the mark.

Leaders of both districts predict their efforts will save money over time, though they acknowledge the initial change has required them to devote more money—and much more time—to teacher training and other planning than if they had not made the shift.

The potential financial savings for districts switching to open resources will vary. But K-12 systems that primarily use digital content are likely to save the most, because they can start using new academic materials without incurring big, new printing costs, said TJ Bliss, a program officer who works on open resources for the William and Flora Hewlett Foundation, based in Menlo Park, Calif.

(The Hewlett Foundation provides financial support for *Education Week*'s coverage of "deeper learning." The newspaper retains sole editorial control over its content.)

It's safe to assume many districts switching to open resources will have to devote large amounts of time and money to finding what they need and preparing teachers to use new materials, Mr. Bliss said.

Yet that work brings rewards, he argued. In going through that process, teachers get "some of the best PD they've ever had."

Building Good Curricula

Commercial publishers often cite the heavy burden schools face in finding and curating open content—as well as concerns about its quality—as reasons to be skeptical of its benefits.

Lisa Carmona, the senior vice president for New York City-based McGraw-Hill Education's K-12 product portfolio, said schools served by her company's resources get more than raw content; they get an array of support to help them make sense of that information.

"Building a good curriculum, let alone a great one, is a challenge," Ms. Carmona said. Content, on its own, "is different than curriculum, and is different than an entire ecosystem." Too often, she said, open content is "missing a lot of those underpinnings."

Still, many states and districts are intrigued enough by open content to take the leap.

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>
> **LISA CARMONA**
> Senior Vice President, PreK-12 Product Portfolio, McGraw-Hill Education

One of the largest open-resource undertakings is being led by the K-12 OER Collaborative, a coalition of 12 states and a group of nonprofits developing resources in English/language arts and math. The collaborative recently hired 10 developers to craft two- to three-week open-resource units, which will become the basis for yearlong curricula, as part of a nearly $30 million project.

EngageNY, initially supported with federal Race to the Top funding, provides open, common-core-aligned English and math resources to K-12 audiences. New York officials say the materials have been downloaded 20 million times by districts and teachers in the United States and abroad.

Ken Wagner, New York's senior deputy commissioner for education policy, said commercial companies are likely to continue to play a critical role in the market in the years to come. At the same time, more districts also may choose to rely on private vendors for "wraparound" services to support educators, while they turn to open sources for core academic content. ■

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Published May 6, 2015, in Education Week

New Research Probes Frontiers Of Tech Learning

By Benjamin Herald

Academic researchers have begun formally examining the latest frontiers in educational technology use.

Their focus: studying how emerging technologies that facilitate new types of hands-on student learning impact teaching, learning, and classroom engagement. They're also looking at tech-enabled instructional practices that provide new windows in children's mental problem-solving processes.

"We are exploring new territory," said Michael Tscholl, a postdoctoral researcher at the University of Wisconsin-Madison. He recently helped conduct a study of MEteor, a "whole-body, mixed-reality immersive simulation" funded by the National Science Foundation in the hope of improving students' grasp of commonly misunderstood concepts in planetary physics.

Other research presented recently at the annual meeting of the American Educational Research Association, held here April 16-20, examined "connected gardening," the use of digital-tablet screencasting technology to plumb students' often-invisible strategies for solving math problems, and the push to get children creating their own digital learning games.

What follows are descriptions of four different researchers' explorations of such new uses of ed tech, as presented at the AERA gathering.

Merging Physical Movement and Virtual Understanding

Most students harbor fundamental misunderstandings about how forces such as gravity and acceleration operate in outer space, said Michael Tscholl, the University of Wisconsin researcher.

That's because their beliefs about physics tend to be based on their experiences in their own bodies, he said. A 7th grader living on earth, for example, needs energy and force in order to move. But the opposite is true for an object in space, which, once launched, will continue moving forever, until a countervailing force provides the energy to stop it.

For decades, Mr. Tscholl said, teachers have tried to overcome their students' misunderstandings around such concepts by having them manipulate symbols on paper, or on computer screens.

But now, he said, that approach is often regarded as ineffective. A superior strategy, some researchers believe, would encourage educators to embrace "embodied cognition," in which students are provided with opportunities for physical activities specifically designed to get them moving in ways that will help them to learn new ideas—and to unlearn some of what they already (incorrectly) believe.

For example: MEteor, a room-size "simulation environment" that calls to mind a space-age version of the popular arcade video game Dance Dance Revolution.

In MEteor, planets and other space objects are projected on the floor and walls. The students must predict the trajectory of an object moving through space by physically moving along the path they think a meteor (projected on the floor) will travel. Laser-scanning technology tracks their movements, offering real-time feedback on whether their predictions are correct. Based on that feedback, students adapt their beliefs about scientific principles, then adjust their movements to reflect what they are learning.

In an experimental study involving 113 middle schoolers, the students who used the simulator (as opposed to a desktop-computer version of the same task) demonstrated greater gains in their understanding of physics concepts such as gravitational acceleration.

They also were significantly more engaged, concentrated better on the task at hand, and reported a greater sense of feeling like a scientist themselves.

And they had more fun.

"What is quite clear is that students are scared of symbolic representations," Mr. Tscholl said. "We are trying to achieve something really big."

The study is currently under review for publication.

Designing a Novel Way to Peek Inside Students' Mathematical Thinking

Many teachers already use screen-casting technology to capture the work displayed on digital devices and create lectures and tutorials for their students.

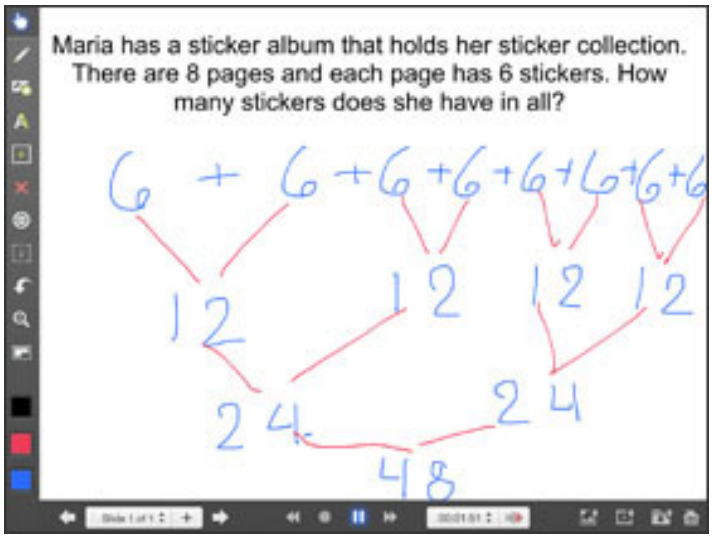
But researchers at San Diego State University and the University of California, Davis, believe formative assessment could be an even more powerful use of such technology. One potential use: getting students to create a multilayered record of their thinking while attempting to solve math problems.

Such an approach could help teachers "go beyond determining whether students correctly solved the problem, to understand why students solved the problem the way they did," wrote Melissa M. Soto and Rebecca Ambrose in an as-yet unpublished paper, presented at the research conference.

To test these beliefs, Ms. Soto and Ms. Ambrose are conducting an ongoing study. During an early experiment, 10 students in grades 3-6 in California and Florida were asked to solve several multiplication, division, and fraction problems using an app called Explain Everything. The children generated screencasts of their problem-solving processes. They also recorded themselves as they verbally explained their work.

The researchers observed and interviewed the students, then analyzed the resulting data and the student screencasts using an original rubric. Their focus was on determining whether the students' verbal explanations of their thinking reflected the problem-solving strategies they actually used, and whether those strategies led to a correct solution.

Particularly noteworthy, Ms. Soto and Ms. Ambrose wrote, were those instances when "students' thinking went astray, or when their verbalizations and notations did not align." One student, for example, incorrectly solved a word problem that required division. By reviewing the screencast of the student's



San Diego State University

Researchers at San Diego State University and the University of California, Davis, are conducting an ongoing study of how educators can use "screen-casting" to capture multilayered records of students' thinking while they are attempting to solve math problems.

work in conjunction with her audio-recorded narration, the researchers were able to ascertain that the student had used a sound problem-solving strategy, but made an arithmetic error caused in part by her haste to finish quickly (and thus demonstrate that she was "good at math").

Without the screencast, the authors wrote, "it would have been difficult to pinpoint where exactly the mismatch took place, and it could have been incorrectly concluded that [the student] did not understand the problem from the start."

Expanded use of screen-casting for formative assessment, Ms. Soto and Ms. Ambrose concluded, has "the potential to transform the learning environment by allowing teachers to gain more insight into their students' mathematical thinking."

They hope to submit their study for publication later this year.

Blurring the Lines Between Playing and Making Digital Learning Games

Over the past two decades, dozens of research studies have concluded that there is educational value in having students create and develop their own video games.

Now, researchers at the University of Pennsylvania and the College of Charleston, in South Carolina, are working to synthesize that research into a coherent theoretical framework in support of "constructionist gaming." Their hope is to influence the growing "serious games" movement, which to date has focused primarily on the development of games for, rather than by, students.

"We need [to] embrace a broader agenda that recognizes that opening access and participation in serious games is not solely a matter of making better games for learning, but allowing students themselves to make the games they would like to see and play," write Yasmin B. Kafai and Quinn Burke in a paper presented at the AERA meeting.

From commercial video games that allow users to alter their avatars' experience, to the open-sandbox world of the hugely popular Minecraft, which includes both a "play" and a "create" mode, the world of digital games offers a wide variety of opportunities for students to create, make, and modify digital worlds.

Such work, in both classroom and informal settings, has been demonstrated to help students increase their knowledge of both coding and academic content. In one study, for example, 4th graders who developed digital games to teach fractions to younger students better understood both fractions and the computer programming language Logo than a comparison group of students.

Constructionist gaming also involves valuable opportunities for collaboration, Ms. Kafai and Mr. Burke wrote. They cited the online communities that have sprung up around such tools as Scratch (a student-friendly computer-programming language) and Arduino (small, inexpensive microprocessors that can be programmed like a computer).

And making their own video games also offers students new outlets for creative expression and new opportunities to critically examine popular media, the researchers contend.

Ms. Kafai and Mr. Burke are currently working on a book, *Connected Gaming: What Video Game Making Can Teach Us About Learning and Literacy*, that is to be published by MIT Press in fall 2016.

"For children in the 21st century, encountering video games is no longer a novel experience in and of itself," they write in a draft of the book's introduction.

In order to take serious gaming to the next level, the authors suggest, educators need to provide students with "a dual sense of being both 'player' and 'maker.'"

'Connected Gardening'

Through iPads and sensor-based "probeware" technology, along with a new curriculum and student-run gardens, researchers at Arizona State University in Tempe aim to help 4th graders become practicing scientists.

Their "connected gardening" initiative allows students to design and develop their own garden plots, then operate technology that provides a constant stream of real-time data about soil-moisture levels, sunlight exposure, temperature, and more.

In a related set of classroom lessons, students also learn about data visualization, data analysis, and plant-growth cycles—skills and information that allow them to adjust the design and operation of their gardens as they go.

Through qualitative research methods, including observations, interviews, and analysis of student work, assistant professor of learning sciences Steven J. Zuiker and graduate student Kyle Wright concluded that such "cyber-physical systems" hold great potential for increasing student engagement and use of scientific practices.

"Typically, garden-based learning has involved very discrete lessons, or powerful after-school programs unrelated to the curriculum," Mr. Zuiker said in an interview.

But the "connected gardening" approach allows for interdisciplinary, project-based instruction, he said. It also "brings the classroom outside the school, with the potential to link with the community."

The researchers are seeking to establish a network of school-based connected-gardening sites in Southwestern states.

Their paper has been accepted for publication in the academic journal *Interactive Learning Environments* later this year. ■

Coverage of "deeper learning" that will prepare students with the skills and knowledge needed to succeed in a rapidly changing world is supported in part by a grant from the William and Flora Hewlett Foundation, at www.hewlett.org. Education Week retains sole editorial control over the content of this coverage.

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Research Uneven, Tough to Interpret

By Sarah D. Sparks

Blended learning is gaining considerable popularity in American classrooms, but the question remains: Is there strong evidence that the strategy helps K-12 students?

"The answer right now is still no," said Sarojani S. Mohammed, a partner and lead researcher at The Learning Accelerator, a Cupertino, Calif., nonprofit group that helps districts implement blended-learning strategies. "We don't have definitive evidence that blended learning works or that it doesn't, though we do know some things about specific aspects."

Blended-learning practices have steadily evolved in classrooms, but there is little consensus on what, exactly, the term encompasses. This further hamstrings efforts to build a solid understanding of whether, when, and how the strategy of combining face-to-face instruction with technology-based lessons actually works.

Research on blended learning has begun to accumulate only in the last few years, with the U.S. Department of Education, the Bill & Melinda Gates Foundation, the Michael & Susan Dell Foundation, and others having recently supported studies of its uses in classrooms.

"Whether blended learning works or not is a frustrating question because the answer is always going to be 'it depends," said Michael B. Horn, a co-founder and the executive director for education at the Clayton Christensen Institute for Disruptive Innovation, in San Mateo, Calif., which studies technology in society. "Depends on how it's implemented, how well teachers are trained. ... It's unlikely to be that blended learning magically causes better learning, and more likely, that it offers better opportunity to provide each student with what he needs when he needs it."

Even defining "blended learning" has proven difficult.

Terms go in and out of fashion—hybrid learning, virtual learning, technology-based instruction, personalization, and so on—and can describe virtually identical or radically different instructional models with disparate levels of technology use.

"Blended learning should be defined as a continuum," said Susan D. Patrick, the president and chief executive officer of the International Association for K-12 Online Learning, based in Vienna, Va. "It's really important for us to realize blended learning is not only a combination of online and face-to-face learning, but that students have some control over time, place, path, and pace."

Coming to Terms

In a 2014 report underwritten by the Michael & Susan Dell Foundation, the research group SRI International studied 13 low-income charter schools using a "rotation" model of blended learning, in which students move among online and in-person stations for different parts of the school day. The SRI researchers who conducted the study found all the schools provided a formal education program with at least some online instruction and some coursework delivered outside the home, and students had some level of control over how they went through the material.

But even within a single model, blended learning looked different from school to school. In some cases, teachers had a big say in which programs students used at different times, while in others, in-person teachers had little connection to the separate labs where students worked online. In still others, self-directed online programs were more likely to be an enrichment for advanced students, while other schools focused on remediation for struggling students.

"In a traditional environment, you're assuming a teacher is teaching the same thing at the same time, so you can code what's happening [in an observation study]. That's much harder with personalized learning," said Ms. Patrick. "It's hard to make general statements about blended learning when 20 different schools have 20 different models."

Ms. Mohammed noted that there are "lots of different flavors" of blended learning," and "the ecosystem has not really congealed around a definition."

And even when studies are all looking at the same learning model, that research is often focused on adults, not school-age users.

A 2010 federal study underscored the scope of the challenge. The Education Department took a broad look at all available studies of online learning, including blended approaches. From 1996 through 2006—the decade in which the Internet rapidly evolved and became ubiquitous—there were no experimental or controlled studies at all comparing online and in-person instruction for K-12 students.

The analysis ultimately found that students in blended-learning classes outperformed those in fully online or fully in-person classes and spent significantly more time on task. But it also found no significant improvements for K-12 students, for good reason: Out of 46 studies included, nearly all examined college-age or adult professional students.

Only five studies covered K-12 education, and they examined academic gains in a variety of subjects and age groups—8th grade social studies, 8th and 9th grade algebra, middle school Spanish, elementary special education—and, for a group of schools in Taiwan, 5th grade science.

Parsing Imperfect Measures

Drawing meaningful conclusions from comparisons of adults' and students' experiences with blended learning is difficult, researchers say. College students, and adults taking on-the-job training courses, may have considerably more focus and motivation to use self-paced, computer-based instruction than K-12 students do, particularly at earlier grades.

One ongoing study by the RAND Corp. for the Gates Foundation is trying to tease out how blended learning plays out in lower grades. Researchers are chronicling how nearly 60 charter and regular district schools implement blended learning, and whether it improves student achievement.

An interim report, covering 23 charter schools and nearly 5,000 students, found students at two-thirds of schools that used blended learning made statistically significant gains on either math or reading tests. But researchers also warned that it isn't yet possible to know "which particular instructional approaches may account for the positive student-learning outcomes."

Of the schools that have seen gains, "it's hard to say if these are just really strong charter schools, or if [blended learning] is playing a role," said John F. Pane, a senior

> The things we have a lot of evidence for—things like early-reading development, personalizing—took decades" to research.
>
> **SAROJANI S. MOHAMMED**
> Partner and lead researcher, The Learning Accelerator, Cupertino, Calif.

scientist at the RAND Corp., who is working on the evaluation.

The time frame for experimental research—five to seven years for most randomized controlled trials—is seen as a problem for conducting studies of education. It poses even greater obstacles for evaluating blended learning, in which iterations of software and curriculum can shift dramatically from year to year.

"The things we have a lot of evidence for—things like early-reading development, personalizing—took decades" to research, Ms. Mohammed said. "I'm not sure that sort of framework is going to be useful in blended learning, where the technology and innovations are changing so rapidly."

From a research standpoint, online instruction would seem to have one clear advantage over in-person instruction: A researcher can't follow a student's thought process as he takes a test, but online programs like Carnegie's Cognitive Tutor can track practically every keystroke entered by every student using the program, allowing analysis not only of what questions a student answers correctly, but how he approaches and works through a problem.

So-called "big data" hold potential to reveal whether a student really understands and can apply a concept, Mr. Pane said, but it's proved to be far from a panacea. The positive results found in a recent evaluation of Cognitive Tutor's blended-learning program, for example, remain in "a black box," with researchers still unsure what exactly caused the improvements in math performance.

"It's a huge volume of data and making sense of it is very challenging," Mr. Pane said. "You get a bunch of keystrokes, but unless you know what was on the screen when those keystrokes were happening, it's mind-bogglingly hard to analyze."

Mr. Horn and Ms. Patrick call for less focus on evaluating individual blended-learning software and programs based only on test scores, and more support for identifying which outcomes schools want, then building measures to test those.

School leaders should not think of online or blended learning as fundamentally different from traditional classroom learning, Ms. Mohammed said. The research suggests they should instead implement it when they "want to solve specific instructional problems," she observed.

"We have not focused on whether learning is actually different in the two different environments," Ms. Mohammed said. "If you take an ineffective practice in face-to-face instruction and move it to an online setting, you shouldn't expect better learning." ■

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Research on Blended Learning

"Mean What You Say: Defining and Integrating Personalized, Blended, and Competency Education"

International Association for K-12 Online Learning (2013)

Provides overview of literature from previous few years; looks at definitions, strategies, tools for personalization, and standards for competency education.

"Personalized Instruction: New Interest, Old Rhetoric, Limited Results and the Need for a New Direction for Computer-Mediated Learning"

National Education Policy Center (2014)

Reviews studies, finds modest gains at best from personalized learning. Examines effective strategies, identifies potential in combining tech-based, person-to-person instruction.

"Does an Algebra Course With Tutoring Software Improve Student Learning?"

RAND Corp. (2013)

Researchers examined popular math program Cognitive Tutor Algebra I; found no significant results in the first year; in second year, students improved performance by 8 percent.

Source: Education Week

Published April 13, 2015, in Education Week's Special Report on Blended Learning: Breaking Down Barriers

Centralized Purchasing Brings Rewards for D.C.

The district has helped schools adopt ST Math, without requiring them to do it

By Benjamin Herold

John P. Rice, the manager of blended learning for the 46,000-student District of Columbia schools, wants every elementary school in his district using ST Math.

But he's stopped short of centrally mandating that principals adopt the program, instead going with an opt-in model—and regular doses of friendly encouragement.

"If I had told all 70 schools three years ago they had to do it, I have no idea where we would be now," Mr. Rice said. "This way, schools are banging on my door to get [ST Math.] It will probably happen in every school soon, but it won't be forced."

During the 2012-13 school year, as part of a larger effort to change mathematics instruction to better reflect the goals of the Common Core State Standards, the district adopted the software. ST Math's developers, the MIND Research Institute, lined up corporate partners to help cover the hefty initial sign-up cost: $34,000 for schools with fewer than 350 students and $48,000 for schools with 350 students or more.

Thirty-one of the city's 70 elementary schools opted to use the software that school year.

But just 11 of those schools met the MIND Research Institute's criteria for "full implementation": 85 percent of students getting at least halfway through the syllabus.

One major obstacle: balancing the student-computing time needed to use ST Math effectively with the demands of three other blended-learning math-software programs the central office had also recommended.

"It was definitely a function of overload," Mr. Rice said. "Some schools just had a hard time being able to regularly get [students] in the computer lab."

Such challenges are fairly common with district-level blended-learning-software adoptions, said Steven M. Ross, a Johns Hopkins senior research scientist.

Photo by Eric Kruszewski for Education Week

Kim S. Burke, the principal at J.C. Nalle Elementary School in the District of Columbia, shows enthusiasm during an open house to explain blended learning software to teachers and leaders from other schools, as Kevin Wenzel, blended learning specialist for the school system, watches.

But in a study released in 2014, Mr. Ross and colleagues found that most district superintendents, chief academic officers, technology directors, and other high-level officials still preferred centralized procurement of instructional software.

That was particularly true when it came to buying software sought for core instruction, as opposed to a supplemental or enrichment tools.

"The bigger the product gets, the more value there is to [purchasing] being centralized," Mr. Ross said.

One reason: Large urban districts in particular have very high student-mobility rates, and it can create problems when students are expected to start with a brand-new curriculum and software if they switch schools midyear.

Like Steven Hodas, a practitioner-in-residence at the Center on Reinventing Public Education, Mr. Ross favors "hybrid" procurement approaches in which district central offices play important, but limited, roles in selecting blended-learning software.

The District of Columbia system has increasingly moved in that direction.

The elementary schools that fully implemented ST Math in 2012-13 saw significant gains: The proportion of students scoring "proficient" or "advanced" on standardized tests rose 19 percentage points, compared with 5-percentage point growth for non-ST Math schools.

Tackling the 2 Sigma Problem: Effective Personalization in K-12 Mathematics

What is the 2 Sigma Problem and Why Does it Matter?

In 1984, educational psychologist Benjamin Bloom found that students who receive one-on-one tutoring perform two standard deviations better than students who learn in conventional scenarios—a single teacher and a group of students, for example. The two standard deviations are the "2 Sigma" referred to in the 2 Sigma Problem. **In essence, the average tutored student outperformed 98% of his or her peers who did not receive tutoring.**

But What is the "Problem"?

Even though Bloom's research and subsequent studies found that students perform significantly better when given one-on-one tutoring, Bloom also observed that providing individual tutors for every single student isn't realistic.

This is the "problem" in the 2 Sigma Problem. We know that tutoring students improves their achievement, but we also know that schools and districts can't afford to provide every student with his or her own personal tutor for every subject.

The Achievement Gap

The 2 Sigma Problem can help us understand one simple cause of the achievement gap. Because students in more affluent communities have access to one-on-one tutoring, they have resources that can help them outperform the vast majority of students who don't receive tutoring.

So the question then becomes, how can we tackle the 2 Sigma Problem and help to close the achievement gap?

How LearnBop Addresses This Challenge

When LearnBop—an automated math tutoring system for K-12 students—was first developed, this was the primary question we wanted to address: How can the benefits of one-on-one tutoring

be replicated in a cost-effective manner to give students everywhere access to the same resources?

When designing LearnBop, math educators who had spent an average of 30 years in the classroom each were asked how they would go about tutoring a student who ran into trouble with a particular problem or concept. Unanimously, they answered that they would guide the student step-by-step through the prerequisite concepts needed to understand the problem originally attempted.

The reason for guiding students step-by-step is that math learning is scaffolded, meaning that each concept builds on prior concepts. If a student doesn't understand a particular problem, it's likely he or she missed a key concept in an earlier lesson.

The best way to help students move forward is to go back over the prerequisite concepts needed to understand the concept currently being studied and help the student master them. Through this tactic, students obtain the strong foundation needed to learn new concepts and address prior knowledge gaps, leading to improved mastery in mathematics.

The Step-by-Step Approach

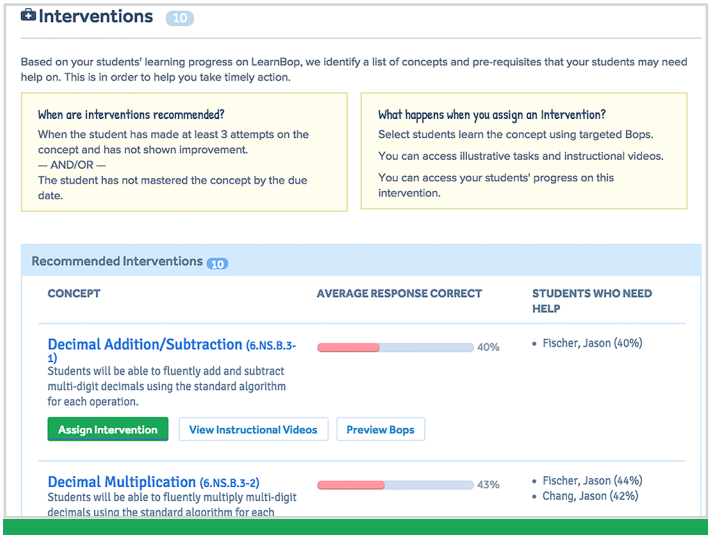
Based on this input from master teachers, LearnBop was created as a step-by-step automated tutoring system with content for K-12 students. Every step in LearnBop's math learning system addresses a prerequisite concept needed to understand the problem originally attempted, providing students with close support in learning prior concepts.

The Power of In-Depth Data

Personal tutors observe a student's performance and recommend additional practice to address students' most challenging concepts. This is why every step in LearnBop is tagged with a mathematical concept, allowing teachers to gain in-depth data showing them exactly what each student needs to master to move forward.

LearnBop automatically analyzes student data and groups students according to their needs, allowing teachers to assign interventions with a click of a button. In this way, students gain the same benefits they would receive from one-on-one tutoring in a manner that saves teachers time and helps personalizes instruction for all students.

Interventions at the Click of a Button



This Sounds Great, but Does It Work?

Yes! A recent efficacy study by research group SEG Measurement found that LearnBop helped students achieve significantly higher learning gains than their peers. Students in the study were divided into two groups, with one using LearnBop and the other not using LearnBop. All participants were given a pre-assessment at the beginning of the study.

After 16 weeks of instruction students were given a post-assessment to evaluate how much their math knowledge had increased.

Did You Know? The "BOP" in LearnBop stands for Behavior Optimization Protocol, which refers to the unique interactive learning experience used in every one of LearnBop's math problems.

The Results

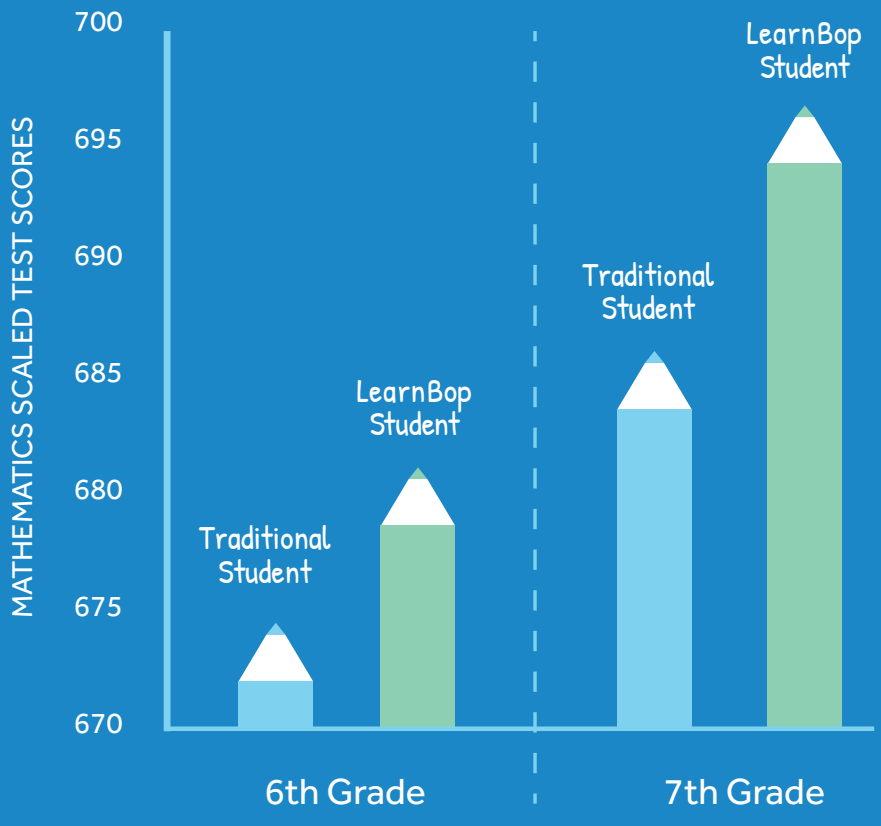
In just one hour of use a week, students who used LearnBop achieved **7-9 percentile points** more growth on post-assessments than their peers. As compared to national averages, students who used LearnBop achieved **40-66% more growth than other students** of the same age. These results demonstrate that LearnBop's approach to solving the 2 Sigma Problem is working to boost math mastery for young learners.

How Do Math Teachers Use LearnBop?

Many teachers use LearnBop as practice for students after teaching a new concept. Because LearnBop acts like a tutor, walking students through prerequisites and gathering data on individual knowledge gaps, teachers can move forward in their syllabus with confidence, knowing that each student is getting the personal support they need to reach their full potential.

"Because every step is tagged with a specific math standard, vital data is collected while students learn."

–Dr. Charlene Marchese
District Supervisor of Mathematics, Freehold Township School District, NJ



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>
> **KIM S. BURKE**
> Principal, J.C. Nalle Elementary, Washington, D.C.

Those results—and some creative professional development (and marketing) by the district—have helped encourage other schools already using ST Math to go all in on the program, and helped persuade schools that did not opt to use the software to reconsider.

In February of this year, for example, Mr. Rice arranged for J.C. Nalle Elementary, one of the schools that embraced the new software most fully, to host an ST Math open house for teachers and leaders from other schools.

Kim S. Burke, Nalle's eighth-year principal, said she appreciated the balance of autonomy and guidance that the district had given her in implementing the new blended-learning model.

"Principals don't always have all the latest cutting-edge information," Ms. Burke said. "It's really helpful when you have a technology office trying to stay on top of those things and saying, 'You might want to consider this'—so long as you're not forced" to adopt software that isn't a fit for your school. ■

Coverage of trends in K-12 innovation and efforts to put these new ideas and approaches into practice in schools, districts, and classrooms is supported in part by a grant from the Carnegie Corporation of New York at www.carnegie.org. Education Week retains sole editorial control over the content of this coverage.

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Doing Ed-Tech Right In the Early Years

By Benjamin Herold

Educational technology in the classrooms of young children is here to stay.

Now, experts say, the challenge is to ensure that all those tablets, laptops, apps, and software programs are used appropriately.

"There is great potential, but we need to be thoughtful and intentional," said Kyle Snow, the research director of the National Association for the Education of Young Children, a Washington-based nonprofit. "At the end of the day, it's still a screen, and we still have to worry about all the bad habits we've developed with other technologies."

The key, say Mr. Snow and others, is making sure that ed-tech is incorporated into a well-rounded classroom. It should add new dimensions to young children's experiences, helping them learn not just to recognize letters and understand numbers, but to explore the real world, interact more closely with adults, and create their own magic.

Preschools and early-childhood centers are likely to have technologies such as digital cameras, computers, and televisions, according to a 2012 survey by the NAEYC and other organizations. Digital tablets and e-readers are less prevalent, and use of such devices may be sporadic, even when they are present.

In the elementary grades, laptops and tablets have become more popular.

But effective technology use is about more than what hardware is in the classroom, said Lisa Guernsey, the director of the Early Education Initiative at the New America Foundation, a Washington think tank.

"It behooves all of us to better understand how technology is being used, what is the content children are seeing on the screen, and how that is integrated into what they are supposed to be learning," Ms. Guernsey said.

The software and app market, for example, has exploded in recent years. Digital math tools for young learners are evolving from quiz-based apps and games to digital environments that require children to solve real-life problems. Literacy tools are moving from online libraries to diagnostic programs that assess students' reading levels and provide targeted lessons and materials. A growing number of apps and software programs aim to address young children's "social-emotional" learning.

Experts say a healthy trajectory begins with limited use of such tools to help preschoolers become comfortable handling devices, explore the world around them, and begin building basic skills. Later, software and apps may become more gamelike, targeting specific skills and content.

> At the end of the day, it's still a screen, and we still have to worry about all the bad habits we've developed with other technologies."
>
> **KYLE SNOW**
> Research Director, National Association for the Education of Young Children

By 2nd and 3rd grades, ed-tech tools may be adaptive, automatically diagnosing a child's reading level or mastery of mathematical concepts. Children in those grades should be exposed to the Internet and content-creation tools, learning how to safely search for information and organize it into everything from presentations to comic books.

Despite considerable hype, solid evidence of how educational technologies support young children's learning remains scant. Worse, teachers and par-

ents often have difficulty finding high-quality digital tools.

"Unfortunately, you get a lot of rote-learning applications that aren't appropriate," said Seeta Pai, the vice president of research at Common Sense Media, a San Francisco nonprofit.

As a result, she said, schools have an increasingly important role to play. That's especially true because children's use of digital technology at home has exploded. According to a 2013 survey by Common Sense Media, 75 percent of children 8 years old or younger have now used a mobile device, more than twice the proportion of just two years prior.

As with television, researchers are worried about obesity, attention span, poor social skills, and other problems resulting from too much screen time.

Parents are also worried about the privacy and security of their children's personal information, and researchers have found evidence that some of the e-books and other digital resources may actually diminish a youngster's ability to comprehend what they read.

And stark differences continue to exist between wealthy and poor communities, both in terms of children's access to educational technology and whether their schools are asking them to produce their own content or engage in drill-and-kill practice of basic skills.

Some exemplars of effective ed-tech usage in the early years have emerged, even within traditional school environments.

That's good—experts say it's more important than ever for parents and educators to be able to recognize healthy use of digital tools.

These days, that means looking at more than just total screen time, said Michael H. Levine, the executive director of the Joan Ganz Cooney Center at Sesame Workshop, a nonprofit research center based in New York City.

The best uses of technology, he said, are "like a ping-pong match," with extensive back-and-forth between children and adults.

"It's not when a device takes over the whole class, but when technology helps a child to go out and discover something in her environment," Mr. Levine said. "It's time to embrace ed-tech, but we have to do it carefully." ■

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COMMENTARY

Technology Isn't Bad for Students. In Fact, It's Character Building

By Stephen Pham

As computers and tablets have become more and more integrated into schools, some educators and parents have raised concerns that the excessive use of technology can be harmful to students. Though there is validity to those concerns in some circumstances, I know from personal experience that the right balance and leveraging of technology enhances instruction. I'd go even further to argue that, far from harming children, the use of digital tools in school inherently teaches them several important character traits.

At first, most young students struggle to operate a computer. They have to learn to navigate a keyboard, know what icons to click, and figure out what all the words mean. As soon as something goes wrong and an error message pops up, they panic and call for help. We've all been there and we know that the learning curve can be steep. But as students gain more independence and more comfort with using technology over time, they begin to develop many soft skills that go beyond the academic-content knowledge or research skills that tech-enhanced lessons typically set out to teach.

For example, allowing students to use a computer or tablet teaches them responsibility. There's nothing like slapping a huge price tag on an item to scare a kid

into treating it with care. Students are used to being given kid-proof belongings, not getting the trust to handle more expensive items (often with good reason). But as soon as we trust them with an expensive tool, they feel the responsibility and trust, and know that they need to be careful. Often, they even take pride in the quality of their care.

Once students discover the immense bank of knowledge online, they are quick to figure out how to access it as well. Students become amazingly resourceful, knowing that they can find almost any fact through the Internet. Whether they're doing research for a school assignment or searching for a how-to for repairing a faucet, they soon develop the ability to access and apply the information that's at their fingertips.

Gaining Independence

As with all forms of independent work, students develop accountability as they work on their individual projects. With self-paced programs in which content is dictated by the progress of the individual user, for example, students aren't forced to move on to new online lessons as they might be in a regular class lesson. So they get the choice to take their time and coast through lessons or work diligently to excel through. The learners have the ultimate control, and thus they develop self-awareness of their work and ownership of their learning.

Most of all, students learn how to problem-solve while using technology. Though tablets and computers are becoming more and more advanced, they are still, at the fundamental level, unintelligent systems programmed to do fancy things. They only do what they're told to do, and they don't typically have the capability to solve random issues on their own. Instead, they require users to identify a problem, find the root, and try different strategies to resolve the issue. This is where human intelligence and intuition come in—traits that take on new powers in combination with the storage and processing capabilities of computers.

Inevitably, when working on computers, students will also encounter technical errors and challenges. Whether it's the software or the hardware, they need to learn how to navigate such issues. At first, students will immediately ask for help in addressing technical problems. But as they observe more and more issues get resolved, they figure out how the systems work and develop the courage to try problem solving themselves. They figure out that they can try some tricks (refreshing a page or restarting the system, to name a couple) and see if their hypotheses work. And best of all, students can take advantage of something computers are uniquely capable of—undoing steps. Nowhere else can someone decide take back a mistake and start again with a quick click of Ctrl + Z. That function can be an important life lesson in itself.

In the end, the character-building piece of using technology is not the main goal in most schools. As educators, we're definitely more focused on the academic and instructional advantages these tools can offer. However, the secondary benefits of developing the skills of accountability and problem solving—both 21st-century skills—with our students is worth acknowledging. ■

Pham is a former 5th grade Integrated Math teacher at Sí Se Puede Academy. He is currently a STEM Integration Associate for Rocketship's network Achievement Team. After graduating from the University of California, Los Angeles, Pham joined Teach For America and is now in his third year teaching at Rocketship. Follow Stephen on Twitter @ stephenqpham.

Published June 18, 2014, in Education Week Teacher

COMMENTARY

How I Blended My Math Class

By Silvestre Arcos

A little over two years ago, my current principal, Danny Swersky, emailed me about his vision for math instruction at KIPP: Washington Heights Middle School, a charter school that would soon be opening in New York City. Specifically, he told me that he wanted to personalize students' learning with the help of technology. He encouraged me to play around a little with Khan Academy, the online lesson-content provider. I was immediately intrigued.

At that point in the school year, I had covered all of the standards that would be on the New York state test and was interested in finding new ways to engage my students while continuing to boost their skills. So I wheeled a set of school iPads into my classroom and introduced my students to the Khan website. Their response was even more enthusiastic than my own. They quickly started using the site to practice skills, earn "energy points," and demonstrate mastery. I was excited about the instructional opportunities this kind of tool might present.

Two years later, I'm the founding 5th math grade teacher at KIPP: Washington Heights. My math classroom and my approach to teaching look quite different than they did during the first decade of my teaching career. In particular, my students spend more time working on the computers and in small groups, and I spend far less time teaching whole-class lessons.

My basic approach is to plan a general mini-lesson that targets a specific common-core standard, emphasizing problem-solving and conceptual understanding. I then look at the skills-progress report generated by the Khan site and group students based on their levels of progress on the standard in question. Students who have shown mastery in the skill complete

a short exit ticket as they enter the classroom and then head to their laptops to go deeper into the topic or explore new topics. Students who need practice or are struggling with the standard complete some warm-up exercises and then take part in my mini-lesson. I scaffold the instruction by modeling and using visual representations to solve the problems along with them. The students then go to their laptops to continue their practice on the standard. At that point, I often bring together the more advanced students to work on a separate activity related to the skill we're working on.

Meeting Individual Learning Needs

Leveraging technology in this way has allowed me to meet my students' individual needs and push them at their current levels of proficiency. As the students work independently or in pairs at their computer work stations, I regularly pull students who need a smaller-group setting to access the day's lesson. I also group students that need support with the language and background information, and I sit and work with students in ones or twos to address specific issues. Everyone in the room is working at their own level and pushing themselves forward at their own pace. By providing lesson scaffolds in various ways, I am able to make sure that all of my students, regardless of their individualized learning plan goals or English-language learning classification, are working on grade-level standards.

This model of math instruction also provides an excellent opportunity to teach students independence and responsibility, as well as to push them to live the character strengths of grit, optimism, and curiosity. At the beginning of every unit, I create posters that list the Khan Academy exercises aligned with our current unit of study from our curriculum scope and sequence. After choosing between Khan Academy and ST Math, a game-based instructional software program, students look at their individual skills-progress reports to decide what they need to practice and then work the exercises at their own pace. Once they have completed the playlist, they can demonstrate their curiosity by exploring new topics.

Once or twice a week, I project the whole-class skills-progress report to give the students a sense of where we are as a cohort and to give them an idea of who is working on the same skills. I frequently confer with students individually to give them feedback on the choices they've made in selecting what skills to practice and what exercises to use. Early in the year I go over strategies that they can use if they are stuck in deciding how to progress. In these ways, I aim to build the students' sense of autonomy and independence and their ability to find their own solutions—characteristics they will need to succeed in later grades. Technology allows for the personalization of their character development as well as their academic development.


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As a teacher, I've also recently been influenced by education researcher Sugata Mitra's TED Talk titled "Build a School in the Cloud," which emphasizes the importance of student collaboration. I've begun to incorporate more collaborative activities into my classroom—for example, by having students work on skills activities in pairs or small groups. I believe the students make significant cognitive and content-understanding gains by asking each other questions and in effect teaching each other the skills.

Shout Outs and Results

At the end of every class, my students have a chance to give a shout out to themselves or others for their accomplishments. "I want to give myself a shout out for leveling up on the exercise on Line Plots," a student might say. "It was difficult for me in the beginning, but I showed grit, stuck to it, and was able to complete the exercise." Students burst into applause and cheers when others earn their first "Sun Badge" to reward them for showing mastery on 100 skills. Once they meet their goals, they create new ones. On my classroom door, I post students' names along with the Khan "energy points" they've earned and the number of skills that they've mastered. The students become increasingly optimistic that they can improve their achievement and their future opportunities through their own effort.

By using this model over the past two years, I've learned that students at every level can make tremendous gains in math achievement. This was not always the case in my classes. I used to see a lot of growth in my students of average proficiency, but I was never as successful in pushing my most advanced students to make significant gains or in making time regularly to help bring up the students who struggled the most. Now I'm finding ways to reach all of my students, many of whom enter our school several grade-levels behind in math.

Over the course of this year, the percentage of my students who were in the bottom quartile on the Measure of Academic Progress benchmarking assessment dropped from 50 to 11. Meanwhile, the percentage of students in the top quartile went from six to 41. Over the last two years, 99 percent of my 5th graders have met their growth goals on the Measure of Academic Progress test. They've also fared well on the state tests, performing above city and state averages and outpacing students in other schools with similar demographics.

Perhaps no less gratifyingly, we have seen students continuing to grow and learn outside of the math classroom. It is not rare for students to call or text me to let me know that they have earned a new badge or that they have met a certain goal. I feel that I am getting closer to achieving my goal of turning all of my students into independent learners.

Next year, I'll be taking on a new position as the math instructional coach in my school. I'm looking forward to working with my colleagues in my school and around the nation on improving and scaling up this blended-learning model. It has helped me see new possibilities in instruction and improved my ability to address students' individual needs—something that is huge for me, as I know it is for all teachers. I'm looking forward to sharing what I've learned about the power of truly personalized math instruction. ■

Silvestre Arcos is the founding 5th grade math teacher at KIPP: Washington Heights Middle School. He holds a master's in bilingual/bicultural education from Teachers College at Columbia University. Arcos was a 2011 winner of Teaching Tolerance's Culturally Responsive Teaching Award and a 2013 winner of New York City's Big Apple Award for teaching excellence.

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