BACKGROUND

By mid-March of 2020, California had closed its public schools in response to COVID-19 and global pandemic concerns. Initially, many districts looked to stopgap measures and focused on maintaining contact with students and families. Soon, however, educators at every level, from pre-K to graduate school, were scrambling to find ways for their students’ learning to continue. Few schools were using products that would support distance learning, and fewer teachers had experience with distance instruction — whether done with virtual platforms synchronously (in real time) or asynchronously (accessed at students’ convenience) or by providing materials to be sent home.

Lists of products to support distance learning began to circulate among educators, and many companies that had web-enabled education products temporarily reduced or eliminated any associated fees. Educators quickly became overwhelmed with
choices and had few ways to filter them. The once seldom acknowledged recognition that few educational technology (EdTech) products had been subject to any, let alone rigorous, independent impact studies became widely apparent. Without sufficient impact data to make choices, school officials were forced to forge their own paths regarding what materials might be best for their students.

To help mitigate this situation for districts across the state, a WestEd research team developed a curated list of math and science products that was informed by research and educators, such as members of the California Partnership for Math and Science Education (CAPMSE). To take this support for districts one step further, the team spoke with educators who were familiar with using the products so that they could share their experiences using the products both before and during the pandemic.

We report on these conversations and our understanding of the products’ strengths and weaknesses in a series of use case briefs: three on science products (Amplify Science, BrainPOP Science, and PhET Interactive Simulations: Science) and four on math products (Desmos, i-Ready Math, Khan Academy Math, and LearnZillion). These use cases represent a careful selection of products, based primarily on their prevalence of use and on educators’ recommendations and engagement. Although we hoped for a more research-driven list, there is a paucity of high-quality impact studies on EdTech products in general (which is a problem for the education field). Nonetheless, these use case briefs are meant to help educators reflect on, learn, and launch conversations about how these resources are being used within the math and science fields.

**IDENTIFYING AND CURATING MATH AND SCIENCE EDTECH PRODUCTS**

This section details the process used to select and learn about the products.

**The Challenge**

We initially planned to present use cases of three to five math and science education products that met impact standards, such as those laid out by the What Works Clearinghouse. The other criteria were the widespread use in CAPMSE districts and alignment with the Common Core State Standards or the Next Generation Science Standards (NGSS). However, after considerable research, we realized that there was no math or science EdTech product that met all three of these criteria.

To help inform and narrow the options for districts, schools, and teachers, we determined to first select a set of EdTech products that met at least two of the criteria.

**The Method**

To begin investigating math and science EdTech products, we prioritized products that provide discipline-specific content in the form of lessons or units of lessons on a topic. The scope included products that were driven by student choice, by teacher choice, and by placement through a diagnostic test. Products could be entirely web-based or could be hybrid, offering both print and digital materials.

Next we selected a subset of products from the numerous lists in circulation during the spring of 2020 in response to distance learning during the pandemic. We then investigated this subset of products to see how well it met our goal criteria. As a first step, we examined the resource lists of three county offices of education for products that

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1 CAPMSE is a partnership that uses a model of communities of practice to build the capacity of educators to advance quality math and science teaching and learning statewide.
were common across the lists. Despite the lengths of these lists, no real patterns were found across the lists, and no products were on all three lists.

We then decided to cast a wider net and review math and science EdTech products with name recognition among educators and that were on lists provided by other education organizations. These lists came from organizations such as NewSchools Venture Fund, agencies such as the Comprehensive Center Network, and experts in the field such as EdReports.

Compiling the Long List

We categorized the products into a long list of resources by grade level and subject area. Because there is a paucity of impact studies on EdTech products, we examined whether each product had a research base, either from internal studies or from research by third parties (e.g., evaluations, academic studies, studies conducted by educational research and development agencies).

In addition to determining whether the products had been researched, we investigated whether the products had been reviewed against established rubrics and evaluation lists, including the Comprehensive Center Network’s Resources for Continuity of Learning and those created by organizations such as EdReports, STEMworks, and the What Works Clearinghouse. Such organizations explore the depth and rigor of studies regarding impact, or they examine whether educational materials are aligned to standards. Thus, these organizations’ rubrics and lists provided us with a version of a third-party analysis of the products’ effectiveness or potential effectiveness.

Finally, to account for statewide considerations, access, and possible needs, we examined whether the selected products were part of the California Department of Education’s adopted curriculum. Although this review of products was not exhaustive, it generated a long list of 64 EdTech products to explore in more depth.

Compiling the Short List

To further vet products for use case scenarios, we refined the selection by prioritizing three grade spans that align with the work of the California County Superintendents Educational Services Association (CCCESA) and Math in Common (MiC): grades PK–2, 3–5, and 6–8. Many products were designed for grades K–8.

Products that had third-party research conducted about them were categorized as having a strong evidence base and were highlighted in the long list. All but three of the products chosen for the short list were in this category. Where possible, we prioritized studies with large student sample sizes. Additionally, products that had been positively evaluated or featured in one or more of the curated lists from the Comprehensive Center Network, EdReports, edshelf, STEMworks, and the What Works Clearinghouse were chosen. This resulted in a short list of 13 EdTech products (six for math, four for science, and three for both math and science).

Creating the Use Cases

We then gathered real-world experiences from educators who were familiar with the 13 products on the short list. To try to understand how much the products were used and to invite participation in focus groups, we sent a survey to members of CAPMSE and to educators who participated in a consultancy series. In the end, seven products were included in the list of use cases — the products that a sufficient number of educators had experience with and were interested in discussing. This final list included two science products (BrainPOP Science and PhET) that had not made it to the initial short list. These products were included because they met the long-list criteria and because the educators we spoke with about them recommended them highly.

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2 The CCSESAsa and MiC have been key partners working with WestEd to advance quality, standards-aligned teaching and learning for all students.
Why This List?

The EdTech products included in our final list and described in the use case briefs have been featured in and crosswalked against various other noteworthy curated lists from the Comprehensive Center Network, EdReports, edshelf, STEMworks, and What Works Clearinghouse. These lists measure various criteria, such as whether reliable research exists to validate queries regarding a resource’s effectiveness and to what extent a resource is aligned with standards within a core content area. The citations of associated research are included in each use case brief for further consultation. Each of these use cases can serve to help educators reflect on, discuss, and engage with real-world math and science experiences in ways that help them better understand opportunities for implementation.

See Appendix: Math and Science EdTech Digital Resources, 2020: Short List to see what curated lists feature the EdTech products described in the briefs, as well as the other products that made our short list. Please note that this list is not meant to be comprehensive, and we expect that some effective products and some products that teachers enjoy using are not included.
**APPENDIX**

**Math and Science EdTech Digital Resources, 2020: Short List**

This short list of math and science EdTech digital resources includes products that in 2020 met the following criteria:

- They are primarily for the three grade spans that align with the work of the California County Superintendents Educational Services Association (CCSESA) and Math in Common (MiC): grades PK–2, 3–5, and 6–8.
- They had a strong evidence base, and studies about them had large student sample sizes.
- They had been positively evaluated or featured in one or more of the curated lists from the Comprehensive Center Network (CC), EdReports (ER), edshelf (ES), STEMworks (SW), and the What Works Clearinghouse (WWC).

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<tr>
<th>Product</th>
<th>Our subject focus</th>
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<th>Type</th>
<th>Description</th>
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<tr>
<td>Amplify Science</td>
<td>Science</td>
<td>K–8</td>
<td>Hybrid</td>
<td>“Amplify Science is a highly engaging, phenomena-based program for grades K–8 that integrates the latest practices in science teaching and learning, as well as interactive digital tools and hands-on activities, to teach students how to think, read, write, and argue like real scientists and engineers.” Amplify options include core and supplemental curriculum, assessments, and interventions for science, math, and English language arts.</td>
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<td>BrainPOP Science</td>
<td>Science</td>
<td>4–8</td>
<td>Digital</td>
<td>BrainPOP is a classroom-optimization tool that provides online learning games, animated videos, games, and activities to help support teaching and learning. BrainPOP covers core and supplemental subjects for upper elementary and middle school students. There is also a version for grades K–3 (BrainPOP Jr.) and a version for English learners (BrainPOP ELL).</td>
<td>Internal &amp; third party</td>
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<td>Desmos</td>
<td>Math</td>
<td>6–12</td>
<td>Digital</td>
<td>Desmos started as a graphing calculator (that was also embedded in digital curricula and assessments) and then grew to providing digital classroom activities for grades 6–12.</td>
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<td>DreamBox Math</td>
<td>Math</td>
<td>K–8</td>
<td>Digital</td>
<td>DreamBox is a fully digital and adaptive learning platform that “closes gaps to deliver results.” It spans K–8 and provides lessons, curriculum, personalized instruction, interventions, assessments, and more. It also has an ELL component for students who speak Spanish.</td>
<td>Third party</td>
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<td>Eureka Math</td>
<td>Math</td>
<td>PK–12</td>
<td>Hybrid (digital/print)</td>
<td>“Eureka Math was written by a team of teachers and mathematicians who took great care to present mathematics in a logical progression from grades PK–12. This coherent approach allows teachers to know what incoming students already have learned and ensures that students are prepared for what comes next. When implemented faithfully, Eureka Math will dramatically reduce gaps in student learning, instill persistence in problem solving, and prepare students to understand advanced math.”</td>
<td>Internal &amp; third party</td>
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<td>HMH Science</td>
<td>Science</td>
<td>K–12</td>
<td>Hybrid (digital/print)</td>
<td>“Designed for an inspiring, high-impact K–12 learning experience, HMH Science Dimensions creates a supportive instructional path for teachers and a dynamic learning environment for students. Teachers guide students to learn through exploration, analysis, application, and explanation — in short, to think like scientists.”</td>
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<td>i-Ready Math (Curriculum Associates)</td>
<td>Math</td>
<td>K–8</td>
<td>Hybrid (digital/print)</td>
<td>“One of the most frequent questions we get about i-Ready is, ‘What does success look like in real schools and classrooms?’ A successful i-Ready implementation is one in which the classroom teacher is at the center. She is making instructional decisions based on her own knowledge of her students and is supported by insightful i-Ready Assessment data that is a complement to her instincts, not a replacement for them. She is taking advantage of the wide range of instructional tools that are part of the i-Ready suite to reach every one of her students — individually, in small groups, or as part of her whole class instruction.”</td>
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<td>Khan Academy Math</td>
<td>Math</td>
<td>K–12</td>
<td>Digital</td>
<td>“Khan Academy offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside the classroom. We tackle math, science, computer programming, history, art history, economics, and more. Our math missions guide learners from kindergarten to calculus using state-of-the-art, adaptive technology that identifies strengths and learning gaps. We’ve also partnered with institutions like NASA, The Museum of Modern Art, The California Academy of Science, and MIT to offer specialized content.”</td>
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<td>LearnZillion</td>
<td>Math</td>
<td>K–12</td>
<td>Hybrid (digital/print)</td>
<td>“LearnZillion integrates with district initiatives, whether they be curriculum, professional development, technology, print, or pedagogy. Our full, coherent curricula include teacher and student materials, assessments, family resources, analytics, and teaching guides to support strategic instruction.”</td>
<td>Internal (impact stories)</td>
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<td>PhET</td>
<td>Science</td>
<td>6–12</td>
<td>Digital</td>
<td>Created by the University of Colorado, Boulder, PhET offers more than 150 free interactive science simulations that cover physics, chemistry, earth science, and biology for middle school and high school. These simulations allow students to play with and visualize science concepts. PhET also provides teacher resources, activities, and more than 2,000 teacher-created lessons that are shared among an online community.</td>
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<td>SEPUP</td>
<td>Science</td>
<td>6–12</td>
<td>Hybrid (digital/print)</td>
<td>“SEPUP (the Science Education for Public Understanding Program) creates innovative science curriculum for use in 6–12 education. Issue-oriented science forms the core of SEPUP’s curriculum materials. Every unit uses personal and societal issues to provide thematic continuity for student investigations and observations. SEPUP is part of UC Berkeley’s Lawrence Hall of Science. Our materials are exclusively distributed by Lab-Aids.”</td>
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<td><strong>ST Math</strong></td>
<td>Math</td>
<td>PK–8</td>
<td>Digital</td>
<td>“It’s a PreK–8 visual instructional program that leverages the brain’s innate spatial-temporal reasoning ability to solve mathematical problems. ST Math’s unique, patented approach provides students with equitable access to learning through challenging puzzles, non-routine problem solving, and informative feedback. With ST Math, students build deep conceptual understanding, and schools see proven, repeatable results.”[^h]</td>
<td>Internal &amp; third party</td>
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<td><strong>Zearn Math</strong></td>
<td>Math</td>
<td>K–5</td>
<td>Hybrid (digital/print)</td>
<td>“Top-rated instructional materials that connect hands-on instruction and digital learning,” Zearn offers curriculum, intervention, professional development, and implementation support. For the K–5 curriculum, “When teachers teach with Zearn Math, kids learn the same concepts twice: once with their teacher and peers and once independently in self-paced digital lessons. The result? Teachers can ensure every child gets multiple pathways into content, unlocking deep learning.”[^i]</td>
<td>Internal &amp; third party</td>
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[^i]: Zearn. (n.d.). [https://about.zearn.org/](https://about.zearn.org/)
This series of briefs presents a broad overview of the research base, functionality, and modes of implementation for a few select math and science EdTech products. Each of these EdTech use cases can serve to help educators reflect on, discuss, and engage with real-world math and science experiences in ways that help them better understand opportunities for implementation. Information on how the products were selected is available in the introduction to the series. Information regarding functionality and implementation was collected primarily through conversations with practitioners familiar with the product — teachers, coaches, and instructional leaders in math and science — complemented by a review of the product or the product website. This brief on Amplify Science is Brief 1 of the full series of seven briefs.
Amplify Science is an online phenomena-based science program for students in grades K–8, developed by UC Berkeley’s Lawrence Hall of Science and Amplify’s digital learning team. The program, which has received a high rating by EdReports for meeting expectations in alignment and usability for its grades 6–8 instructional material, provides a comprehensive curriculum with sequenced units, hands-on science learning, interactive tools, and integrated reading, writing, and thinking activities. Amplify Science is a subscription-based product that includes student books, teacher guides, materials kits, and simulations for practice at the elementary level. Material for middle schoolers also includes notebooks and digital science articles. Amplify also offers programs for math and English language arts.

NEW IN 2020 WITH AMPLIFY SCIENCE

In August 2020, Amplify Science launched a new remote learning solution called Amplify Science@Home Units, with resources that teachers and students could use during extended remote and hybrid learning as a result of the COVID-19 pandemic. These resources include home units, which are adapted units that modify instructional time and highlight core activities; home videos that provide guidance for families; and teacher training and support.

To understand how teachers and students have been using Amplify Science effectively, the WestEd research team spoke with teachers, a project director returning to the classroom, and a science consultant. These educators were all familiar with Amplify Science and its ranking among EdTech products, with one having gone through the program’s pilot process early in its implementation.

They unanimously agreed that Amplify Science offers students engaging and aligned science curriculum with science routines, simulations, and projects that teachers can readily implement. They noted that the content helped facilitate teaching for newer teachers but could feel scripted to a seasoned educator. They also noted that the units require a time commitment of multiple class periods, and they suggested providing teachers with training and support for the program’s technological aspects.

What Do Educators Highlight About the Program?

The educators we spoke with appreciated Amplify Science’s collection of progressive science content. They said that it offers a coherent and cohesive curriculum that has “all the parts” needed to facilitate science teaching and learning, such as three-dimensional science statements and good story lines. They specifically appreciated the sequence of learning the product offers to students.

The educators also noted that Amplify Science provides targeted supports and modeling for students and teachers alike. For students, the educators thought that the curriculum offered solid routines and assessment opportunities, prompts and expected responses, and simulations and final projects. They said that these projects allow students to justify and defend decisions and rationales made about science in order to help illustrate that concepts have been understood.

For teachers, Amplify Science provides the science rationale so that they know what to look for in student understanding and learning. This rationale explains not only the “science background,” as one educator noted, but also the what and the why of what is happening within the science lesson and where to go from there.
They offer a rationale, which I think is really helpful for teachers, especially — I’m thinking middle school or elementary teachers that are [in] self-contained [classrooms] and may not have a science background.”

How Might Teachers Use Amplify Science?

As one educator noted, choosing a curriculum is a way to support teachers not only during the pandemic but also beyond. Because Amplify is a curriculum, it has units that educators said are available for teachers. These units build on one another and take the “onus” from the teacher, who doesn’t have to “try to figure everything out and what the child is learning.” The units also include literature and reading, thus integrating literacy and language. The educators also noted that Amplify Science can be used with other platforms and that, as a practice, teachers can front-load the science phenomena into lessons or add them to other instructional materials.

“...The one nice thing about Amplify is, if you are a new teacher and you’re coming in, the curriculum is there. You could follow it from beginning to end and you would get a cohesive curriculum, and that’s a great base to build on.”

Though they thought highly of Amplify Science, the educators noted multiple considerations to keep in mind, particularly the time required and the scripted feeling of the lessons. Amplify Science has addressed the time issue in response to the pressures of teaching during the pandemic, creating condensed units and adapted lessons. Although the educators noted that the scripted lessons could be helpful for newer teachers or for those with less knowledge of science content, more seasoned teachers might feel constrained by them.

WHAT DOES THE RESEARCH SAY ABOUT AMPLIFY SCIENCE?

Internally conducted research on Amplify Science includes field trials and case study reports. Field tests conducted from 2013 to 2016 with more than 400 teachers and 34,000 students indicated positive program impacts (Amplify Education, Inc., 2019a). These initial studies showed that students using Amplify Science outperformed peers on measures of learning by an average effect size of 0.45 (Amplify, 2019a, 2019c).

Internal testing of Amplify Science elementary for grade 5 in 33 Washington schools during the 2017/18 school year showed statistically positive effects for students who met grade standards, with participating students having an average of +3.47 points over the control (Amplify, 2019d).

During the 2018/19 school year, the Yukon Public Schools conducted a phased rollout of Amplify Science, starting in grade 8 with more than 650 students. Data from this case study show that students made progress in mastering key science content for force and motion and metabolism from the beginning of a unit to the end (76% and 78% growth, respectively), through “increasingly complex explanations of phenomena” (Amplify, 2019b).
What About Student Engagement?

The educators we spoke with noted positive student engagement with Amplify Science. They said that engagement occurs at the beginning of a lesson and through the sequencing of the curriculum’s topics. The story line of each lesson engages students with the scientific process, and the curriculum is attractive and easy for parents to navigate, offering them a point-and-click resource. However, the educators suggested paying attention to accessibility, avoiding content repetition so that students remain engaged, and possibly providing communication to parents on how to use Amplify Science at home.

“I think [Amplify Science] is very engaging. I think they pick topics that students are interested in. I think they connect it back to students.”

References


This series of briefs presents a broad overview of the research base, functionality, and modes of implementation for a few select math and science EdTech products. Each of these EdTech use cases can serve to help educators reflect on, discuss, and engage with real-world math and science experiences in ways that help them better understand opportunities for implementation. Information on how the products were selected is available in the introduction to the series. Information regarding functionality and implementation was collected primarily through conversations with practitioners familiar with the product — teachers, coaches, and instructional leaders in math and science — complemented by a review of the product or the product website. This brief on BrainPOP Science is Brief 2 of the full series of seven briefs.
BrainPOP is a subscription-based online classroom-optimization program that provides short animated videos, learning games, and student-centered activities to help support teaching and learning for upper elementary and middle school students. The WestEd team spoke with educational coaches and specialists about their experiences with BrainPOP Science in particular, but the program also focuses on multiple other subjects: social studies, English, math, arts and music, health and social emotional learning, and engineering and tech. There is also a version for grades K–3 (BrainPOP Jr.), a version for English learners (BrainPOP ELL), and versions in Spanish and French.

The educators highlighted BrainPOP’s versatility, and they underscored opportunities for visual integration and science differentiation, English language development and learner supports, and subject content integration. They stressed that BrainPOP Science is a relatively straightforward technology tool for teachers to use. They also thought the program offered supplementary content that provides “accurate science” for teachers to embed into curriculum, to align with the Next Generation Science Standards (NGSS), and to promote student engagement.

BrainPOP SCIENCE IN ACTION AND ONLINE

The educators we spoke with have seen BrainPOP Science used to engage, elaborate on, and create coherence in student discourse both synchronously and asynchronously. For English learners, this might mean watching a short BrainPOP video and using sentence frames and structures to join an online science discussion. The product can also be used for in-person or virtual breakout sessions, with students paired with partners or placed into small groups. Students can watch a BrainPOP video on their own or together, share their thoughts about science practices, and then watch the video again and reflect with the whole class online.

What Do Educators Highlight About the Program?

Many of the education specialists, coaches, and a consultant we spoke with about the program’s highlights were familiar with the program, noting that it had a long history of use since it was first released 20 years ago. They mentioned that BrainPOP Science’s visual components allow for the integration and differentiation of scientific material. This helps to introduce core science principles to students and set them up to “see” and later experience hands-on science application. In particular, the educators thought that the animated videos and characters helped students build science understanding and engagement and could be used as a “bridging platform” to meet students’ learning needs.

The educators noted that BrainPOP’s language content offers beneficial supports for English learners and other students who are developing English skills. They explained that the BrainPOP ELL content can help teachers streamline planning and provide targeted supports. The educators also highlighted that BrainPOP provides more than science content. They saw the social emotional, social science, and language resources as opportunities to integrate and cross-pollinate content areas and to help build students’ reading, writing, listening, and speaking skills. They also said that this integration supports the distance learning environment by helping draw connections across content areas in ways that create
a sense of classroom community and that allow teachers to consolidate time and efforts.

“I’ve also heard [that BrainPOP is] successfully being used for the socioemotional side of the connection, as we all know is probably the most important thing right now because our students are carrying that extra weight.”

How Might Teachers Use BrainPOP Science?

The educators were unanimous in stressing that BrainPOP Science is a supplementary program that does not offer a complete curriculum. Rather, they said that BrainPOP can help expand and bolster student learning in conjunction with a teacher’s or a district’s chosen science curriculum, which for distance learning might be an online program such as Amplify Science or adapted classroom units.

“I think a lot of this, all of these resources, have really solid potential, but a lot of times it boils down to the teacher understanding the spirit and intent of NGSS and the pedagogy we want to utilize.”

They also noted that BrainPOP Science is easy to use and is material-independent, so teachers at all levels of experience with technology and access to resources can navigate it. They said it is up to teachers to create coherence and to find avenues for integrating aspects of the program. BrainPOP Science content can also be aligned to the NGSS, and the program itself offers a crosswalk to these standards.

What About Student Engagement?

The educators also noted that BrainPOP Science offers digestible, relatable, short, and concise videos that are safe and comfortable for students to watch. They noted that the videos have a “fresh” look that students pay attention to and like to watch. The topics and animation complement the science subjects and offer reliable material that students can refer to as “evidence and reasoning” for scientific claims. The videos also provide relevant and timely information, such as a cartoon about COVID-19. The educators thought that the material created new resources that were not only student-friendly but also easy for parents and caregivers to use. They mentioned that the videos are accessible outside of the classroom experience, are on a user-friendly online platform, and are available both in English and in Spanish. Talking about the videos through the lens of a parent, one educator felt he could “manage” the BrainPOP material and thus “go through the journey with my kids.”

“So any time that we look at the resources, and now because of this pandemic, we have to consider, is this something that my parents aren’t going to be able to manage and maybe support at home?”

WHAT DOES THE RESEARCH SAY ABOUT BrainPOP?

Research conducted by BrainPOP and third-party researchers has shown promising outcomes in student learning, teacher instruction, and academic performance. Findings from a study with 418 students in grades 5–7 who participated in integrated science and technology lessons at least once a week indicated student performance gains. The researchers found that integrating BrainPOP animations into the classroom significantly increased the ability of
students in the target group to transfer scientific and technological knowledge (Rosen, 2009).

Research has also shown evidence of BrainPOP’s impact on overall academic and test performance. A study that examined statewide test results of BrainPOP subscribers and nonsubscribers across five states found significant positive effects on student performance in math, English language arts, and science assessments (BrainPOP, 2018). Additional analysis also indicated positive results and found that the strongest effects of the program were for students in grades 3–6 math and science; this analysis qualifies as promising evidence under the Every Student Succeeds Act (ESSA).

Finally, a multisite, controlled study of students in grades 3, 5, and 8 also explored BrainPOP’s effectiveness. Approximately 1,100 students in 46 classrooms in Florida and New York participated in this study. The study found significant improvements in science, reading, comprehension, language, and vocabulary skills for the target group compared with the control group (SEG Research, 2009).

References


This series of briefs presents a broad overview of the research base, functionality, and modes of implementation for a few select math and science EdTech products. Each of these EdTech use cases can serve to help educators reflect on, discuss, and engage with real-world math and science experiences in ways that help them better understand opportunities for implementation. Information on how the products were selected is available in the introduction to the series. Information regarding functionality and implementation was collected primarily through conversations with practitioners familiar with the product — teachers, coaches, and instructional leaders in math and science — complemented by a review of the product or the product website. This brief on Desmos is Brief 3 of the full series of seven briefs.
Desmos is a free resource that launched in 2011 as an advanced and intuitive graphing-calculator web application for grades 6–12. Today Desmos offers a suite of products, including four calculators, a geometry tool, classroom activities, professional learning, a distance learning guide, and a mobile app. Desmos’s calculators can be found in college entrance exams and in state assessments in 36 states, and Desmos partners with numerous assessment organizations, including the Smarter Balanced Assessment Consortium. Desmos is connected to both the College Preparatory Mathematics (CPM) and Illustrative Mathematics (IM) curricula.

NEW IN 2020 WITH DESMOS

- Desmos created distance learning collections, including curated activities oriented toward asynchronous teaching and organized by grade level (6–8) and by topic (algebra through calculus).
- Desmos created new synchronous learning tools, including a co-teacher feature and icebreaker screens.
- In 2020 and 2021, Desmos, in partnership with IM, launched a pilot of its complete middle school curriculum, a hybrid digital and physical curriculum that builds on Desmos’s supplemental activities.

The WestEd team spoke with middle and high school math teachers, a math coach, and district and county instructional specialists about Desmos. These educators were passionate about the product and agreed that Desmos is the one must-have math app. They talked about how it inspired students and teachers alike, and how they increased their use of it when they were required to shelter in place for the COVID-19 pandemic. They also appreciated Desmos for its ease of use, interactive capabilities, peer conversation supports, and student-work presentation supports. One coach said her teachers stopped using Google Slides once she learned how to use Desmos to design and deliver her lessons.

What Do Educators Highlight About the Program?

Teachers and coaches commented on the flexibility of Desmos. They use it as everything from a calculator app on mobile devices to a comprehensive learning management system that allows them to deliver activities, organize pair discussions among students, collect and then share student work, and monitor student progress. They also appreciate Desmos’s connections to other curricula, such as CPM and IM, and the integration of the calculator into the state assessment. While some teachers had had professional development to learn how to use Desmos, most found the design intuitive for teachers and students, so they could figure it out “by just playing around” with the calculators and activities.

“They’re using Desmos and it’s, like, why would I even bother with Google Slides anymore?”

How Might Teachers Use Desmos?

Desmos works well for in-person, distance, synchronous, and asynchronous learning. Some teachers use Desmos as a comprehensive resource to deliver math lessons,
activities, and curriculum. These teachers might use the program’s lesson-pacing functions, which allow them to monitor how quickly students move through an activity’s slides. Other teachers use the graphing calculator embedded inside lessons. These teachers appreciate the way the calculator lets them change values and display a numeric table and a graph picture at the same time, facilitating student understanding of the relationships between the two representations. One coach discussed how Desmos supports teachers’ math content knowledge, particularly if the teachers have never taught with graphic calculators.

**What About Student Engagement?**

The educators all agreed that students in beginning math through calculus classes find Desmos engaging and easy to use. Students benefit from the versatility of the app, which allows for both simple and complex computation to be handled in the same place. Teachers talked about students being so engaged in Desmos activities that they did not want to pause. One coach advised teachers to “underteach” the product and allow students to discover some of the functions and capabilities themselves.

“In our district [a lot of our students] don’t care about some of the [examples] mentioned in there, but they like boba. So we change all those [examples]. And we talk about ratios. So you can really utilize those capabilities and create to your needs and match your program, whichever program you’re using.”

**WHAT DOES THE RESEARCH SAY ABOUT DESMOS?**

There are no large-scale research studies on the impact of Desmos on student achievement or teacher learning. A few small studies have been completed, and they show a positive impact. A quasi-experimental study that examined the use of Desmos in beginning algebra showed that students who used Desmos scored higher on scenario problems and on a diagnostic test of the concept of slope than students who did not use Desmos (Puhl, 2019). A similarly designed study found a statistically significant difference in problem-solving confidence scores between middle and high school students who used the Desmos graphing calculator and students who used a TI-83 Plus graphing calculator, while controlling for student math achievement scores (Montijo, 2017).

Although they did not conduct an impact study, Satsangi and Miller (2017) offer Desmos as an example of how digital manipulatives can be beneficial for students with disabilities. Other studies present different ways of using Desmos and its potential benefits for formative assessment (Read Jasnoff, 2018), creating inclusive classrooms (Caniglia & Meadows, 2020), teaching the concept of limit in calculus (Liang, 2016), and even math art (Banting, 2016).
References


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Developed by Curriculum Associates, i-Ready is an individualized learning product that serves students in grades K–8 and that provides diagnostic testing and scenario-based lessons in math and English. i-Ready is a subscription-based product, generally adopted at the district level. It is part of the Curriculum Associates suite of math and reading products, which also includes Ready (a core curriculum) and Brigance (in-depth skill assessments for early childhood and special education). i-Ready is anchored in a comprehensive system of assessments designed to be given at the beginning, middle, and end of the school year. These assessments can then be used by districts and teachers in a variety of ways, such as placing students in the i-Ready instructional program. Many districts in California mandate i-Ready’s diagnostic tests and recommend that the product be used for 45 minutes per week, the use time promoted by Curriculum Associates.

NEW IN 2020 WITH i-READY

i-Ready has developed a comprehensive set of resources and guides for the remote learning environment, which are available on its website. These include:

- guidance for proctoring assessments on Zoom,
- how-to tips for using each product in remote settings,
- top 10 tricks for remote teaching in general, and
- resources for families.

The WestEd team spoke with a district math coach and two math teachers on special assignment (TOSAs) about their experiences using, and supporting teachers who use, i-Ready Math. The educators stressed that i-Ready is a supplement, not a curriculum, and does not teach material. They reported that the most effective use of i-Ready is as a reinforcement to the lesson taught during class time. This use works particularly well in conjunction with the Ready curriculum. The educators appreciate the immediate feedback that i-Ready provides students during independent work time. Although they noted the potential power of the diagnostic tests, they also expressed frustration with how their school sites use, or do not use, the data from the tests. They also observed that i-Ready’s diagnostics and lessons are challenging for English learners.

“I see [i-Ready diagnostics] as a tool for teachers, for our coaches, for our school site administrators, and for the district administrators to cohesively create something that is going to utilize [EdTech] effectively and appropriately for every learner in every class.”

How Might Teachers Use i-Ready Math?

All the educators agreed that i-Ready is best as a tool to support the teaching of a core curriculum. They were concerned that teachers and administrators might lean too heavily on the product’s instructional elements in the distance learning environment during the COVID-19 pandemic. They found that an effective use for the program is to use the i-Ready lesson as homework in order to reinforce information the teacher had already taught in a lesson.
“[I recommend that teachers] do a mini-lesson on Zoom and then assign the correlating lessons to their class right afterwards that mirror what they just taught. I think that that might be a worthwhile something for the kids to do, because it does give them immediate feedback.”

Implementing a Districtwide Product

At the time of the focus group, the educators worked in districts that had purchased and endorsed districtwide use of i-Ready, and all were in roles that allowed them to observe the product’s implementation at many school sites. These educators noted challenges regarding consistent use of the diagnostic data and instructional tools that i-Ready provides. One educator described the perils of leaning on i-Ready for primary instruction. She described one grade 7 teacher’s students as having excellent i-Ready scores but being unable to complete performance tasks or hold mathematical conversations. Another educator described her district using the diagnostics as one part of placing students into math courses, particularly grade 9 algebra. In this educator’s observation, this use, coupled with variation in the use of the product, yielded unequal access to math courses.

All the educators expressed frustration at the inconsistent use of i-Ready data across sites in their districts. Many sites do not use any of the data from the tests given at the beginning, middle, and end of the school year, and few leverage the diagnostics’ potential as a universal screener or as a means of providing formative feedback for instructional planning. During the focus group, pointed comments were made regarding the discrepancy between the resources put into the purchase of i-Ready and the resources put into supporting effective and consistent use of the product. i-Ready does offer professional development, and the educators recommend that districts that have obtained the program or that are interested in implementing it might do well to budget for these services. In addition, consistent and frequent messaging around expectations for use of the product seems important. Finally, the educators highlighted that a critical implementation piece should include a plan for use of the diagnostic data yielded by the three tests per year.

“What does the research say about i-Ready Math?

i-Ready is a highly regarded program that has garnered full marks from EdReports and that is supported by research that connects the product to student achievement. Curriculum Associates, developer of i-Ready, has both undertaken internal analyses and contracted with research organizations to understand the impact of the product (Curriculum Associates, 2017;
In the 2014/15 and 2015/16 school years, the Educational Research Institute of America (ERIA) analyzed data from thousands of students across multiple states who took both the i-Ready diagnostic exam and either the Smarter Balanced Assessment Consortium standardized test or a particular state’s summative evaluative test. In each analysis, ERIA concluded that i-Ready diagnostic scores were strongly correlated (in the 0.80–0.90 range for all of grades 3—8) with scores on the Smarter Balance tests administered to students in 2015 and 2016 (ERIA, 2015, 2016).

Research fellows at the Johns Hopkins University offered a more nuanced reading of the ERIA studies. They explained that the analysis done by ERIA represents “construct validity” of the i-Ready assessments, but they believe more evidence is needed to establish content validity, or an “alignment between the test questions and the content it is intended to assess” (Bjorklund-Young & Borkoski, 2016).

Finally, in an exhaustive study for her dissertation, Rachel Aguilar (2019) found that the thrice-year testing i-Ready recommends did not provide much benefit to schools or to students. She recommended that students be tested only once per year.

References


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Khan Academy is a free online platform with a comprehensive offering of educational content, including mathematics content, lessons, and problems from kindergarten math to calculus. Originally conceived as a program to support tutoring, in recent years Khan Academy has included features to accommodate teachers and schooling. Khan Academy Math offers grade-level “missions” in which math content, videos, and quizzes are organized according to grade level. The product also provides a teacher dashboard that facilitates assigning students specific math content, lessons, and parts of grade-level missions; administering quizzes; and monitoring student progress in real time and through summative reports. Khan Academy Math provides almost endless problem sets for students, and students can gain points and earn in-site rewards for successfully completing problems. Students have the option of getting a hint (the next line in the product’s solution to a problem), although every hint costs points.

NEW IN 2020 WITH KHAN ACADEMY

- In July 2020, Khan Academy replaced “missions” with “course mastery.” The courses are still organized by grade level but start with a diagnostic test. It is not immediately clear what standards the K–8 courses are organized by, but some of the courses are connected to Eureka Math/EngageNY.
- In June 2020, Khan Academy developed a distance learning guide. As of that time, this resource had not been vetted or reviewed, but developing the guide indicates Khan Academy’s willingness to adapt to COVID-19 conditions.

The WestEd team spoke with elementary, middle, and high school math teachers and math coaches about Khan Academy Math to understand how to use the product most effectively. All were familiar with Khan Academy since its founding in 2008 and noted how its platform has changed over time. They appreciate Khan Academy Math as a broad resource for lesson planning, lesson augmentation, and their own learning and for their students to practice and review math. We noted that when the educators were required to shelter in place for the pandemic, none of them changed their use of Khan Academy, although they appreciated that it was available on mobile devices — they used the product similarly and had similar experiences with student engagement.

What Do Educators Highlight About the Program?

The educators reported that Khan Academy Math works well as supplemental material. The product excels in providing practice and review opportunities to students. They also noted that it is a good support for parents. These educators also appreciate the grade-oriented missions and other specific course offerings, such as SAT prep as a way for self-motivated students to increase their mathematics work.

The educators had mixed experiences with two of Khan Academy’s instructional elements, the videos and lessons. They noted that steps in these elements were often unclear or missing, particularly in the older videos, and thus they make sure to review all videos and lessons prior to suggesting them to students. In addition, they observed that the tangential information presented in the videos confuses and distracts many students. None of the educators reported that they use the placement
assessments, quizzes, or real-time reporting, nor did they mention the resources in languages other than English.

Finally, all the educators found Khan Academy Math helpful as a refresher for themselves when switching grade levels or courses, as a reference for planning lessons, and as a resource for parents who want a refresher on grade-level mathematics.

“We’re trying to teach students to think like mathematicians, to think beyond the algorithms, which I don’t think Khan Academy does. For parents, helping students go back to math, I think it’s a nice refresher for them.”

How Might Teachers Use Khan Academy Math?

The educators found Khan Academy Math particularly useful for student-paced math practice. Some teachers support this practice by posting Khan Academy lessons or units so that students can earn extra credit. Others assign the grade-level mission and require students to complete a percentage of the mission, allowing them to choose which lessons to work on. One teacher noted that the product’s problems are very similar to those on the SAT and that she encourages her students to use Khan Academy Math to study for that exam.

“My kids that tend to enjoy it more are [those who] just needed more time on a concept and more practice. I taught it, we’ve worked with it a bit, and they just needed more time for them to really grasp it.”

The comprehensive nature of Khan Academy Math makes it an excellent library of math resources. Teachers use the product to support lesson planning, refresh their own math knowledge when teaching a new grade or course, and provide students with a different perspective on a concept, such as by showing a video to the class. They also assign specific videos, lessons, or problem sets to students or classes if a student or the class needs more support to master the concept.

What About Student Engagement?

All of the educators found Khan Academy Math to be most compelling for their self-motivated students and for students who enjoy the “computational” aspect of math. The educators expressed frustration at the points system, noting that often the students who need hints are deterred from using them by the potential of losing points. In addition, they found the videos to be problematic, particularly the older ones. They observed that steps are often missing in the videos and that the tangential information presented in them confuses and distracts many students.

“I’ve noticed that my visual learners, especially if they’re lower-level learners, struggle with [Khan Academy Math].”

WHAT DOES THE RESEARCH SAY ABOUT KHAN ACADEMY MATH?

Internally conducted research on Khan Academy Math has shown promising results. A study completed in Long Beach Unified School District indicated that students who used Khan Academy Math for more than 30 minutes a week scored an additional 22 points on the mathematics portion of the 2018 Smarter Balanced
assessment compared with students who did not use Khan Academy Math (Hill et al., 2020).

To date, rigorous large-scale independent evaluations of Khan Academy Math have not been published. Numerous small-scale studies have found mixed results. A large-scale exploratory study conducted in 20 schools by SRI Education found that students who spent a significant amount of time with Khan Academy (more than 12 hours per year for grade 5 students) did better than predicted on end-of-year achievement tests (Murphy et al., 2014). A study conducted in Idaho in 2013 had similar results, with students who used Khan Academy performing 1.5 to 1.8 times their predicted growth on the MAP Growth test (Phillips & Cohen, 2014). Two studies compared use of Khan Academy with standard instruction and found no significant impact on student test scores (Gray et al., 2017; Adams, 2016).

References


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LearnZillion is a subscription-based product that offers standards-aligned, highly regarded mathematics curricula for students in grade K through Algebra 2. The product began as a set of free digital resources that were designed to offer short supplemental activities and thus provide teachers with a comprehensive, but not overwhelming, digital and printable curriculum. LearnZillion subsequently adapted the Illustrative Mathematics (IM) open-source lessons to its platform, and it is one of four certified IM partners. Although neither LearnZillion nor IM have yet conducted any research studies on the effectiveness of their curricula, both products align to the Common Core State Standards for Mathematics, are respected in the field of math education, and scored full marks on EdReports evaluations. It is for these reasons that LearnZillion is included in WestEd’s curated list of math and science EdTech products.

LearnZillion has integrated two popular and standards-aligned interactive apps into its lessons: Desmos (a free graphing calculator) and Geogebra (a free geometry tool). As a holdover from its prior free, supplemental offerings, LearnZillion continues to provide a few lessons without a subscription. The product boasts seamless integration with any district-designated learning management system and student information system in order to ease deployment across schools and districts. LearnZillion also offers professional development for teachers.

NEW IN 2020 WITH LEARNZILLION

Perhaps because LearnZillion was already working on making curricula available digitally before schools went remote in response to the COVID-19 pandemic, it did not have any offerings specific to the pandemic.

The WestEd team spoke with an elementary school teacher and a district math coach about LearnZillion and IM. The coach had a long history of supporting teachers who use LearnZillion. However, when LearnZillion became a subscription-based product, her teachers lost access to it. During the spring of 2020, the elementary school teacher began using the free LearnZillion resources, which she accessed through her Nearpod subscription. As a result, neither educator had experience with LearnZillion’s full-subscription offerings.

“When we switched to Common Core, LearnZillion [and] all their videos [and] step-by-step instruction helped our teachers to become more comfortable with the instruction. So not only [are they] using it with their students for intervention, a lot of [the] time the teachers use it to help them improve their instruction.”
What Do Educators Highlight About the Program?

The math coach appreciated LearnZillion as educative curriculum, the kind of curriculum that provides instruction and support to both the teacher and the students. In her observation, the LearnZillion lessons provide a gateway to Common Core math practices for the teachers with whom she has worked. Both educators enjoyed the way LearnZillion breaks down concepts into small chunks that are driven by activities and supported by videos. This feature makes LearnZillion easy to integrate into teachers’ lesson plans. Importantly, the educators appreciated the balance between procedural and conceptual learning that is supported by LearnZillion activities.

How Might Teachers Use LearnZillion?

If a school has a LearnZillion subscription, the platform’s integration with IM allows teachers to use it as a primary curriculum. But even if a school doesn’t have a subscription, the limited free lessons that LearnZillion provides through its website and through Nearpod offer engaging activities that can provide entry points for students as they learn new concepts or review concepts they learned previously. During the beginning of remote instruction, the teacher we spoke with assigned her students activities on topics they were already familiar with in order to keep them engaged with math without being overwhelmed. The ability to select stand-alone activities on specific concepts is a strength of LearnZillion. However, the coach stressed that the product needs to be thoughtfully implemented in order to maintain cohesion across the year. These educators recommended using LearnZillion for review and for increasing student engagement with activities, but noted that these features should always be connected to a coherent and comprehensive curriculum.

“[After the fractions lesson,] a couple of my kids said just, like, ‘Oh, that’s what that is,’ things like that, and like, ‘Oh, OH! I can do that.’ . . . [F]or some of them it just clicked.”

What About Student Engagement?

The educators reported that their students were highly engaged with LearnZillion. The activities provide instructors with multiple ways to draw in students, ask thoughtful questions, and provide visuals and videos. The teacher described numerous “aha” moments for her students when they were working with LearnZillion. One critique of the product — particularly for younger students — was that the introduction slides for the activities can be challenging. These slides are text heavy, and the educators often choose to skip them or to summarize them for their students so that the students can dig into the math activity.

“[Instead they’d see] two-sevenths, three-elevenths — just weird, different numbers . . . I liked the choices [LearnZillion] made in terms of fractions they were using. . . . [Students] could see the visual model of how they could do it; it made sense . . . And then there was the video.”
WHAT DOES THE RESEARCH SAY ABOUT LEARNZILLION?

Despite launching in 2011 and 2008, respectively, neither LearnZillion nor IM have yet conducted any research studies on the effectiveness of their curricula. However, both resources score highly on EdReports, a rubric-driven evaluation conducted by trained teachers to assess the coherence, focus, rigor, and usability of products.

On its website, IM features use cases that describe positive teacher, student, and administrator engagement with IM materials. In the 2019/20 school year, IM partnered with four school districts to measure impact on students and teachers. Although the study was interrupted by the pandemic, IM designed tools to measure impact, which are now available for districts that are using LearnZillion or other certified IM sources.
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PhET offers free interactive science and math simulations online for teachers to use and engage students with. Created by the University of Colorado, Boulder, PhET offers more than 150 science simulations that cover physics, chemistry, earth science, and biology. These simulations, or sims, allow students in middle school and high school to play with and visualize science concepts, with some simulations also providing accessibility features such as interactive descriptions, sound, or alternative input. The PhET site also provides teacher resources, activities, and more than 2,000 teacher-created lessons that are shared among an online community. Moreover, translations for 93 languages are available for some simulations.

NEW IN 2020 WITH PhET
In response to the COVID-19 pandemic, the PhET team developed resources such as remote learning tips, HTML5 prototype simulations, and browser-compatible Java simulations; these resources are provided on the PhET website. Remote learning tips provide guidance for teachers on finding the right simulation and embedding it within lessons, ideas for promoting student inquiry and thinking, and strategies for scaffolding teaching and learning. The website also provides tips for troubleshooting compatibility issues for Java and Flash simulations, including using screen captures or video posts.

The educators all agreed that PhET simulations can help build science understanding by providing students with visuals and manipulatives that they can use to explore learning for themselves. One teacher further described the resource as “incredibly valuable” for conceptual understanding. The educators also mentioned that PhET can be used and adjusted to reach various lesson and learning ceilings and that it helps with a differentiated strategy for understanding. They also felt that the simulations could be used to model and prepare students for state assessment. The way that PhET is designed, they said, aligns with the content and expectations of the California Science Test (CAST). One educator shared teachers’ observations that students referred back to PhET simulations as a way to provide evidence and reasoning for their science knowledge.
"It was the first, and only, simulation that actually made sense, that actually showed good science behind it. And that was one of the great, let’s say, game changers, for us to actually see two-dimensional expression. And at the same time, [students] would be able to change variables, to understand data collection, and have representation of that information."

The educators mentioned that PhET requires both student and teacher exploration. They noted that some simulations require that educators have guidance and understanding in order to be able to lead students through learning. They also cautioned that teachers should not think that the simulations themselves are phenomena; rather, the simulations are tools and resources to help explain or help visualize science experiences. The educators encouraged teachers new to PhET to create a free account to be able to access the teacher supports that PhET provides, such as tips for scaffolding, simulation alignment, and shared lessons.

**How Might Teachers Use PhET?**

PhET simulations can be used in a variety of ways for both synchronous and asynchronous teaching and learning, and can be integrated with platforms such as Nearpod and other education technology programs. The educators listed opportunities for individual students to access the simulations at home and on multiple platforms, and they mentioned that teachers could establish student pairs in a virtual class. They also suggested using PhET to provide students with science connections or hands-on activities within Zoom breakout rooms in remote learning environments during the pandemic. Breaking students into pairs and small groups, they noted, would allow students to try simulations together, think about them, analyze and discuss them together, and then bring their learning back to a larger online class session for a “whole-room” conversation, much like a class “Science Talk.”

"[Teachers] were saying PhET simulations [were] something they really wanted to keep using because of the student engagement. [The class] could have them both synchronously and asynchronously, like tasks that were set up for the lesson while they were all meeting, but then also tasks that they could take back and work on with their model, like their RAFT kit model."

**WHAT DOES THE RESEARCH SAY ABOUT PhET?**

There is a large body of research on PhET interactive simulations, student perspectives and interests, and classroom use. For example, researchers have found that some students interact with PhET simulations in ways that help them experience learning as a scientist does and that these students appreciate the simulations’ visual dynamics and levels of complexity (Wieman et al., 2008).

A study used PhET simulations to explore the student-level effects of computer simulations compared with actual laboratory equipment in a large-scale introductory physics course. The researchers found that students in the group using the simulations outperformed the control.
What About Student Engagement?

The educators said they had found that PhET simulations offer short supplements for interested students to engage with and play with, and that teachers need to choose accompanying material in order to hold students’ interest past initial exploration. Some students, they said, engage with the simulations in ways that tap into their preferred learning modalities. Other students may need more guidance and support, while some may be disinterested. In general, however, they said they thought students liked the hands-on learning, the figuring out, and the interactive aspects of the simulations. “That’s the thrill of actually enjoying science again,” one educator noted. “It’s by doing, not necessarily just by reading.”

References

