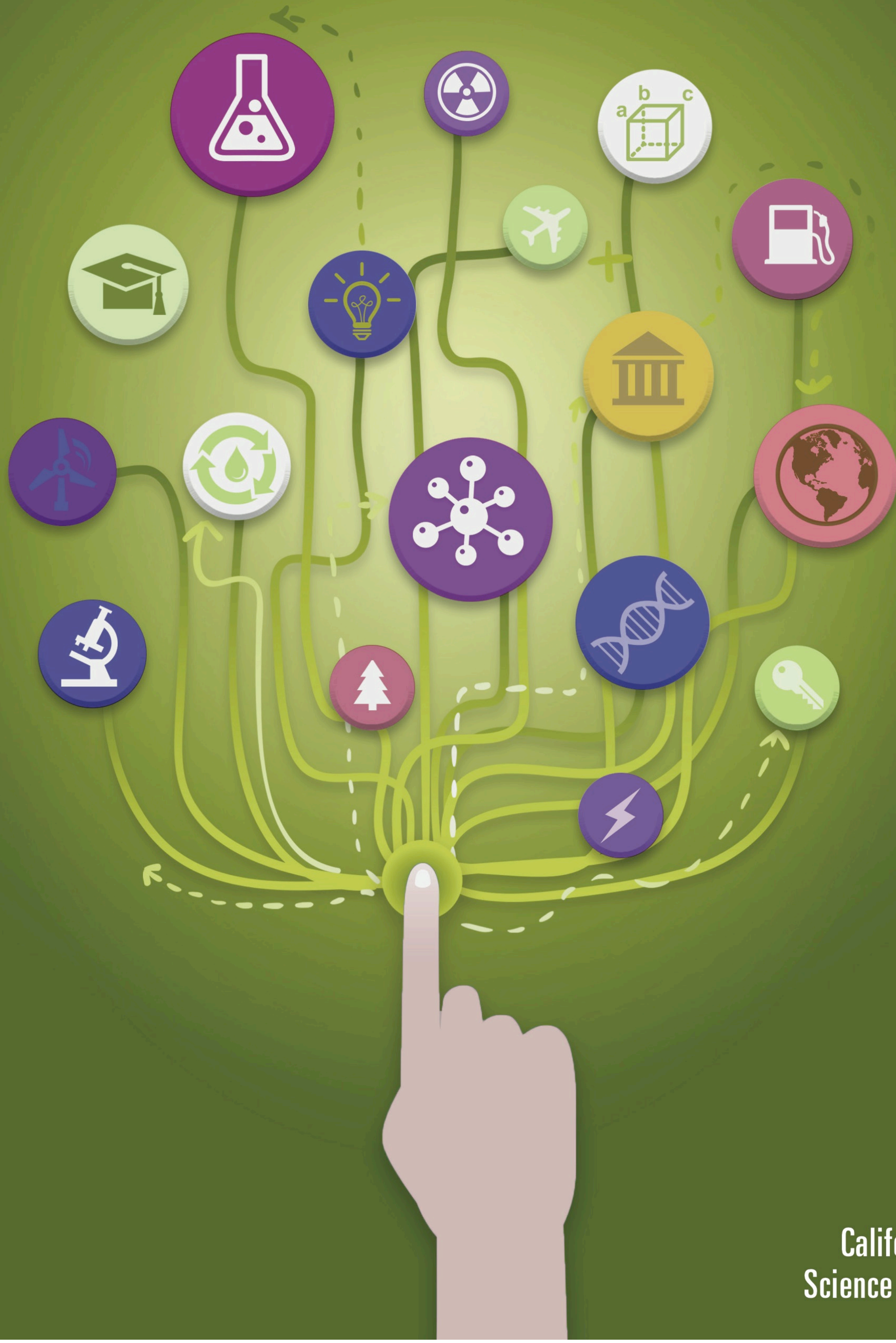
# THE EFFICACY OF DIGITALLY ENHANCED EDUCATION

## SUMMARY OF SYMPOSIUM DISCUSSIONS



March 2014

California Council on Science and Technology

# The Efficacy of Digitally Enhanced Education - Summary of Symposium Discussions

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ACKNOWLEDGMENTS

We are deeply grateful to the Stephen D. Bechtel Jr. Foundation and the Stuart Foundation for providing support for the Symposium Series. In addition, we want to thank those who joined us around the table, graciously giving of their time to explore the issue of efficacy in the field of digital teaching and learning. We especially want to recognize their pioneering spirit and their willingness to allow others to learn from the risks they have borne to advance the field of education.

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 CCST is a non-profit organization established in 1988 at the request of the California State Government and sponsored by the major public and private postsecondary institutions of California and affiliate federal laboratories in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending public policies and initiatives that will maintain California's technological leadership and a vigorous economy.

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## Executive Summary

Digitally enhanced education (DEE) has arrived in California's classrooms, but there is little data or evidence-based guidance about what works, for whom, and under which conditions. To explore these issues, the California Teacher Advisory Council (Cal TAC) and its supporting organization, the California Council on Science and Technology (CCST), convened a series of symposia, the most recent of which was held on September 13, 2013 at the California Department of Education in Sacramento, California.[1] The Efficacy of Digitally Enhanced Education in California series brought together representatives of the education, technology, policy, research, and philanthropic communities; it was designed as an ongoing conversation among those with distinct but complementary perspectives on the efficacy of DEE.

These conversations yielded a complex and rapidly changing picture of the role of technology in education. They exposed a wide gap between expectations for technology use in the classroom and disappointing results from some studies of the effects of these technologies on teaching and learning. Although California, home to Silicon Valley, is a cutting-edge state, it has not embraced DEE in a way that would derive maximum benefit for its more than six million students. Despite the allure to embed digital teaching and learning quickly into every classroom, it is wise to take a careful look at the extent to which DEE is fulfilling the promise of access, increased engagement, and higher achievement for students. To move forward responsibly, much more must be done to provide sound and reliable data to inform decision-making in support of effective DEE. Studies on which the digitalization of education must rely should be designed to detect meaningful effects on teaching and learning by emphasizing unique features of technology connected to proven learning principles, as well as looking at an entire package of integrated curriculum, technology, professional development, and assessment.

> **"Data is not the plural of anecdote."**
>
> Jeremy Roschelle, Co-Director Center for Technology in Learning SRI International

As reported at the symposium, a summary analysis of recent research on DEE notes that:

- The research is strongest in enumerating learning theories, curricular design frameworks, approaches to teacher professional development, and assessment designs. However, it falls short in informing policy in terms of telling us what works in general, or guiding instructional decision-making by teachers in the classroom. "Technology may be doing something, but the test we have isn't equipped to measure it."[2]
- Research should seek consistency — or at least less variability. Currently, DEE has yielded some isolated success stories, yet at scale, these individual effects are canceled out.
- While a major advantage of DEE is to deliver improvements that are equitably distributed and close existing achievement and equity gaps, in practice these and

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[1] http://ccst.us/ccstinfo/caltac/2013sept_symposium.php

[2] Jeremy Rochelle, The Efficacy of Digitally Enhanced Education, Symposium II, Sacramento, CA, September, 2013

other investments yield a "Matthew Effect,"[3] where many or even most students may improve, yet gaps are preserved because the rich (or advantaged) just get richer as well.

In addition to what has been learned about the current status of DEE-related research, the need for caution regarding two popular but flawed approaches to the implementation of digital approaches has come to light:

- Platform Initiatives, in which teachers or classrooms may receive new hardware (such as laptops, whiteboards, or tablets), but without any details on how these are tied to or incorporated into any instructional change. As a result, not much change is observed between teachers and learners.[4] If instruction does not change or the technology turns out to be too time-consuming or unproductive, or is poorly aligned with standards or other requirements, it will not gain traction and yield the hoped-for results.
- Organic Initiatives that encourage experimentation with new curricula that utilize technology ("let a thousand flowers bloom!"), with the aim of harvesting what works to spread effective ideas and approaches: While this empowers early adopters, it is very difficult to move to scale from individual successes.

These approaches may be part of a successful initiative, but are not a sufficient solution.

Given what we have learned to date about the efficacy of DEE, what should be the next steps to transform classrooms in ways that would enable them to rapidly accommodate a changing learning environment and the ubiquitous presence of technology in students' lives? Can DEE fulfill its promise as a great equalizer, ensuring that economically disadvantaged children and second-language learners have the same educational opportunities of their more advantaged, English-speaking peers?

**"It's a good time for us to be thinking at the state level about setting expectations and supporting the kinds of technology-related changes we're trying to make. In both pre-service programs and ongoing professional development, we need to create learning ecosystems that are self-perpetuating, with teachers coming to the environment prepared to act and be agents of teaching and learning."**

Mary Vixie Sandy, Executive Director
The California Commission on Teacher Credentialing

[3] A Matthew Effect is the phenomenon of accumulated advantage, in which the rich get richer and the poor get poorer.
[4] Means, B., Roschelle, J., Penuel, W. R., Sabelli, N., & Haertel, G. (2004). Technology's contribution to teaching and policy: Efficiency, standardization, or transformation? *Review of Educational Research, 27*, 159-181.

In order to answer these questions, we must shift from thinking about technology as an add-on, and move towards a more integrated understanding of what is possible. The recommendations below are offered as a starting place to develop sound, research-based approaches to the implementation of DEE for every student in every school:

1. Research supported by federal, state and private entities should be designed to detect meaningful effects on teaching and learning by emphasizing the unique features of technology connected to proven learning principles and looking at an entire package of integrated curriculum, technology, professional development, and assessment. Criteria should include the five characteristics of past studies that were able to detect meaningful effects, including:
    a. Emphasizing unique features of technology that are connected to a proven principle of learning.
    b. Focusing on how technology helps teachers convey something that is hard for them to teach and/or for students to learn, in "right-sized" blocks. Individual lessons would be too small to create a measurable change, while a year-long change might be too overwhelming — so a good block to test might be a module or unit that lasts several weeks.
    c. Integrating curriculum, technology, professional development, and assessment. The entire package is important.
    d. Emphasizing teacher productivity and alignment. This means tactical work to assess large and small barriers to the productivity of teachers in the classroom that steal minutes away from other work and frustrate teachers enough that they reject the technology altogether.
    e. Measuring what matters. Currently, tests are too blunt or misdirected to really measure the kinds of learning we'd like to see, but the Common Core State Standards (CCSS) may offer some opportunities for better alignment between what we test and what we want students to know.

2. Support research that explores the effect of digital teaching and learning on cognitive skill development for diverse student groups, including those who are English-language learners and who are economically disadvantaged. To make an assessment of learning meaningful, include measurement of the extent to which there is access for all to tools, software, online resources, and support as well as the ways in which students engage with and use these technologies.

    AB 484 (Bonilla),[5] signed into law on October 2, 2013 by Governor Brown, establishes the California Measurement of Academic Performance and Progress (CalMAPP) assessment system and provides an opportunity for education leaders, working together with business and government, to form a consortium to get schools wired in order to pave the way for an effective use of technology. We agree with the recommendation from the Education Technology Task Force established by State Superintendent Tom Torlakson, that collaborations between education and industry partners in public-private programs should be encouraged along with the

[5] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB484

creation of “modern, personalized assessments by providing essential technology, infrastructure, and professional development based on CCSS formative and summative computer-adaptive assessments.”

3. Marry innovation with research at every step in implementing DEE alongside the Common Core State Standards and Next Generation Science Standards (NGSS). The convergence of CCSS and NGSS with new technologies present real challenges to the ways teachers teach and students learn (e.g., engaging students, prompting a sense of inquiry, giving students tools to provide evidence for their arguments and organize their thoughts and questions). Program planning strategies that take into consideration the following key implementation elements are essential, including:
    a. Equipment;
    b. Tech support;
    c. Professional development; and
    d. Adequate planning time.

4. Design systems that make changes possible for all or most teachers, without jeopardizing the productivity of those having the greatest potential for embracing all that technology has to offer their students.
5. Recognize and build on a critical role for the statewide teacher-development system, including pre-service programs, induction, and professional development. Take care to create learning ecosystems that are self-perpetuating, with teachers coming to the environment prepared to act and those already in the classroom adequately supported to build on and extend this learning.

## Introduction


Digitally enhanced education (DEE) has arrived in California's classrooms, but its scope, implementation, and impact have been very unevenly distributed, systematically tallied and researched, or well understood. This report summarizes discussions from the second in a series of symposia designed to explore and report on the status of DEE in California, with the goal of developing a "toolkit": that is a guide for members of the education, policy, and philanthropic communities as they make future investments in this crucial yet still murky realm.

In her welcoming remarks to symposium participants, California Council on Science and Technology (CCST) Executive Director Dr. Susan Hackwood noted the culture clash between the worlds of education on the one hand, and technological advances on the other. Because of its sense of responsibility for the mind of a young person, she observed, the education world tends to move very carefully and deliberately. But in the technology arena, changes and experiments are welcomed and seen as the route to progress and success. The lubricant WD-40, for example, is named for "Water Displacement Experiment #40" — the success following 39 failed attempts.

DEE is spreading to more and more classrooms and school districts, but there is little data or evidence-based guidance about what works, for whom, and under which conditions. The symposium series was convened to help bridge the gap between the education world's need for deliberation and caution in adopting DEE, and the surge in real-world experimentation with DEE that we see at every level of the education system.

New resources for helping educators assess and make better use of DEE tools are springing up rapidly, including the following:

- Graphite (www.graphite.org), 2013, Common Sense Media — Helps educators find the best apps, games, Web sites, and digital curricula rated for learning. Reviewers base ratings on a rubric that evaluates the learning potential of ed-tech products. Teachers can enter their own "Field Notes" about how best to use the technology in a K-12 classroom and create Pinterest-type boards of their top picks to share with peers.
- EdClipper (educlipper.net), 2013, Adam Bellow, educator and education technologist — Gives educators and students a social learning platform into which they can "clip anything, share everything." This Pinterest-type site gives educators and students a place where content can be saved and added to a clipboard to share. It allows teachers to differentiate instruction and students to create personal learning portfolios with examples of their work.
- EdShelf (www.edshelf.com), 2013, Mike Lee, Internet entrepreneur and former software developer — Helps teachers find the right educational tools for their needs. Educators recommend what works in the classroom. Using a "star" system, they assign ratings based on learning curve, pedagogical effectiveness, and student engagement.

- PowerMyLearning (www.powermylearning.org), 2011, CFY (originally termed "Computers for Youth"), a national education nonprofit — Takes the guesswork out of finding and using K-12 digital learning activities. A team of educators curated thousands of academic games, videos, and interactive software, tagging them by subject, grade, CCSS, and more.

But what are educators, policy-makers, parents and others to make of this rapidly growing and changing field? How can students best be served through the implementation of DEE?

With the help and generosity of thought partners from across the technology, education and policy spectrum, CCST and the California Teacher Advisory Council (Cal TAC) welcomed the opportunity to explore the efficacy of digital teaching and learning. Further, they wish to invite others into this continuing conversation.

## A Symposium Series to Examine the Efficacy of Digital Teaching and Learning

The CCST's Cal TAC responded to the gap in data about DEE's efficacy and coordination of DEE-related policies by launching a Symposium Series in 2012. The series brings together representatives of the education, technology, policy, research, and philanthropic communities; it is designed as an ongoing conversation among those with distinct but complementary perspectives on the efficacy of DEE. (For a list of Symposia participants see Appendix A.)

Cal TAC Chair Brian Shay began the most recent conversation by posing questions that have shaped discussions throughout the Symposium Series:

- What do we know about the efficacy of DEE?
- What works, why and for whom?
- What context and circumstances either hinder or enhance digital modes of teaching and learning?
- What education policies need to be in place to make the most of these opportunities and ensure their equitable distribution across schools and systems?

This report summarizes discussions from the second Symposium in the series, which took place in Sacramento, California on September 13, 2013. In addition to continuing and updating discussions from the first Symposium about what is currently known about the status of DEE and how it can facilitate the implementation of the new CCSS and NGSS, the overall goal of the second Symposium was to develop a better shared understanding of the efficacy of digital teaching and learning, in order to rethink what the related policies and practical issues should be. The symposium also offered opportunities for participants to discuss the next iteration of Massive Open Online Courses (MOOCs) and review the current policy context.

As with other Cal TAC gatherings, the Symposium Series aims to highlight the voices and insights of classroom teachers to inform policy and research.

### *About Cal TAC and CCST*

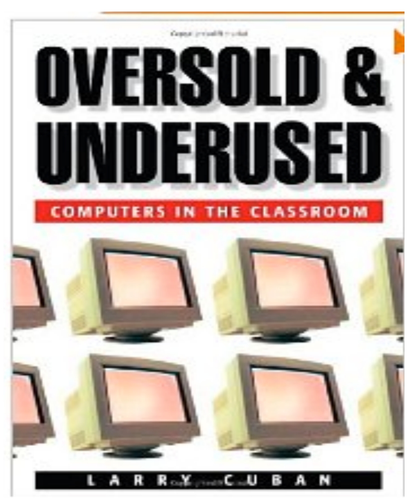
Cal TAC was created by CCST in 2005 to serve as a conduit for bringing real-world classroom experience — the "wisdom of practice" — to policy-makers and others whose decisions affect the quality of STEM education in California. It is modeled on the national Teacher Advisory Council affiliated with the National Academy of Sciences, tapping the talents and creativity of California's outstanding Science, Technology, Engineering, and Mathematics (STEM) teachers.

CCST is a nonpartisan, not-for-profit corporation established 25 years ago to offer expert advice to the state government and to recommend solutions to science- and technology-related policy issues, modeled in part after the National Research Council that serves the National Academies of Science and Engineering. CCST's core support comes from California's major post-secondary institutions, which provide important backing, support, and resources to CCST. CCST is governed by a Board of Directors composed of representatives from its sponsoring academic institutions, from the corporate and business community, as well as from the philanthropic community. Together, these members are helping both the public and private sectors find answers to the important science- and technology-related issues facing California.

## Research, Evidence, and Digital Learning

### *An Overview from Dr. Jeremy Roschelle, Co-Director of the Center for Technology in Learning at SRI International*

Jeremy Roschelle told the symposium participants the "messy" story of technology, evidence and education by highlighting one particular published study, and then considering its broader implications.[6] As the title of one research report suggests, technology in the classroom is often "oversold and underused." Roschelle observed that when rigorous studies of promising technologies have been conducted, the results have often been disappointing.




For example, the Department of Education's "Effectiveness of Educational Technology Interventions" found net effects that were zero or weak for 16 promising technologies. Another way to think about this finding, Roschelle explained, is that the results of technology use were highly variable, with positive effects being cancelled out by negative ones.

In other research, analysts have grouped studies that meet specific criteria and used the technique of meta-analysis to estimate average effects. Some meta-analyses find a positive

[6] Roschelle, J., Shechtman, N., Tatar, D., Hegedus, S., Hopkins, B., Empson, S., Knudsen, J. & Gallagher, L. (2010). Integration of technology, curriculum, and professional development for advancing middle school mathematics: Three large-scale studies. American Educational Research Journal, 47(4), 833-878

average effect (one example is Aimee Ellington's research on graphing calculators), but the technologies involved are considered outmoded. Indeed, given that technology can be used in many ways and that technologies are rapidly evolving, it is unclear whether making blanket assertions about technology and effectiveness will ever be possible. Indeed, Roschelle cautioned against treating technology as a direct causal agent, but rather seeing it as an enabling component for developing more effective systems of instruction, where the system of instruction involves much more than the technology.

Existing research is strongest in articulating learning theories, curricular design frameworks, approaches to teacher professional development, and assessment designs. However, it falls short in guiding policy in terms of telling us what works in general, or guiding instructional decision-making by teachers in the classroom. While this may seem like a contradiction, it is not.

An analogy may help: imagine a goal of improving student nutrition, instead of improving student learning. Scientific research on human biology may develop theories that are very useful for designing nutritious meals — for example, that we should think about proteins and carbohydrates, not soft foods and hard foods. Food scientists may also uncover new ways to prepare foods in healthy ways — design frameworks for cooking. However, despite advances in biology and food science, students at school may not choose to eat healthy diets for myriad reasons or it may prove too hard to implement the healthiest plans at scale outside of isolated test kitchens. Hence, there is a need for implementation research to figure out "what works" in terms of programs for healthy eating at school, which relates to but is not the same as biological or food science research. In the case of research on learning technology, we presently have a stronger base at the learning principles or design frameworks level than at the level of how to achieve successful implementations across large numbers of schools.

### *The Challenge: Designing Research that Helps Us Get to Where We Want to Go*

One way to close the gap between what we want from DEE and what it can deliver is to work on defining better research that tells us more of what we want to know, Roschelle suggested. For example, DEE is appealing because it offers the potential of moving quickly to scale — a particularly attractive proposition in large states like California. We also want to see positive effects — not the mixed or unmeasured effects that current research suggests. "Technology may be doing something," Roschelle noted, "but the test we have isn't equipped to measure it."

> **"Technology may be doing something, but the test we have isn't equipped to measure it."**
>
> Jeremy Roschelle

We also seek consistency — or at least less variability. Currently, DEE has yielded some isolated success stories (including those described by Cal TAC members at previous meetings), yet at scale, these individual effects are canceled out. "Data is not the plural of anecdote," Roschelle pointed out.

Finally, we want DEE to deliver improvements that are equitably distributed and close existing achievement and equity gaps. In practice, though, these and other investments yield a "Matthew Effect," in which many or even most students may improve, but gaps are preserved because the rich (or advantaged) get richer as well.

### *Evaluation Research Reveals Two Commonplace Failures in Approach*

Roschelle suggests that evaluation research points to two common failures in implementation. The first he described as "platform" initiatives, in which teachers or classrooms may receive new hardware (such as laptops, whiteboards, or tablets), but without any details on how these are tied to or incorporated into any instructional change.[7] As a result, not much change is observed between teachers and learners. If instruction does not change or the technology turns out to be too time-consuming or unproductive, or is poorly aligned with standards or other requirements, it will not gain traction and yield the hoped-for results.

A second type of failure includes the "organic" initiatives that encourage experimentation ("let a thousand flowers bloom!"), and then seek to harvest what works and spread effective ideas and approaches. While this empowers early adopters and maverick teachers, it is very tough to accomplish the "spread" part of the equation, moving away from individual successes. These approaches may be a part of a successful initiative, but are not the entire solution.

### *An Alternative: Principled Designs*

Given these flaws and failures, what are some alternatives? Roschelle identified five characteristics of studies that were able to detect meaningful effects:

- Emphasizing unique features of technology that are connected to a proven principle of learning.
- Focusing on how technology helps teachers convey something that is hard for them to teach, and/or for students to learn, in "right-sized" chunks. Individual lessons would be too small to create a measurable change, while a year-long change might be too overwhelming — so a good chunk to test might be a module or unit that lasts several weeks.
- Integrating curriculum, technology, professional development, and assessment. The entire package is important.
- Emphasizing teacher productivity and alignment. This means tactical work to assess large and small barriers to productivity that steal minutes away from other work and frustrate teachers enough that they reject the technology altogether.
- Measuring what matters. Currently, tests are too blunt or misdirected to really measure the kinds of changes we'd like to see, but the CCSS may offer some opportunities for better alignment between what we test and what we want students to learn.

[7] Means, B., Roschelle, J., Penuel, W. R., Sabelli, N., & Haertel, G. (2004). Technology's contribution to teaching and policy: Efficiency, standardization, or transformation? *Review of Educational Research*, 27, 159-181.

### *The SimCalc Example*

To illustrate these principles, Roschelle described studies he and his colleagues have conducted assessing the SimCalc program, developed by Jim Kaput at the University of Massachusetts.[8] SimCalc software uses visual simulations to help students grasp key mathematical concepts — such as proportional reasoning — that tie across different math and science courses and are foundational for scientific reasoning overall. Using the learning principle of dynamic representations, the software supports conceptual understanding by helping students connect a familiar, visual image — such as a soccer player in motion — with narrative, algebraic, graphed, and tabulated data. The idea is that technology is uniquely able to link different representations (graphical and narrative, familiar and formal) so that students can make these "a-ha!" connections themselves.

> **"We want things that are a benefit for 90% of teachers, not just the superstars."**
>
> Jeremy Roschelle

Beyond the software that allows the visualizations, the program also organizes a sequence of learning (including software, text, and discussion) and includes a teacher professional-development component. The teachers experience the software as learners and have an opportunity to experience how their own understanding of proportionality changes, so that they can teach differently.

Studying the effects of SimCalc on students and teachers was expensive; the series of comparisons Roschelle described cost approximately $6 million. The first-year randomized study in Texas included 95 7$^{th}$-grade teachers and 1,621 students in 73 schools, including urban areas as well as rural areas that included high poverty levels and Spanish-language households. The treatment group taught with SimCalc; the control group taught the 3-week proportionality module as usual.

> **"Designing systems that make changes possible for all or most teachers, without jeopardizing their productivity, have the most potential."**
>
> Jeremy Roschelle

When the Texas state basic skills test was used, it did not detect much difference between the two groups, in part because of a "ceiling" effect in which many students already were performing at 90-100%. In other words, there was no room for growth that the Texas basic skills test could measure.

However, the researchers also used a test that they built based on Teacher Information Management System (TIMS) items that are used for national and international comparisons. This test was far more challenging — and far better suited to measuring the advances SimCalc aimed for.

With the more sensitive TIMS test, a larger difference between the treatment and control groups was detected. Some superstar teachers, Roschelle noted, will engage with their

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[8] http://www.kaputcenter.umassd.edu/products/.

students and convey these concepts whether they have technology and professional development or not. But for 90% of the teachers, their students were better off under the treatment conditions (with SimCalc and more extensive professional development) than without. "As broad policy concerns," Roschelle observed, "I think we want things that are a benefit for 90% of teachers, not just the superstars."

In terms of equity concerns and closing achievement gaps, Roschelle noted that while students in the treatment group overall learned more than their peers in the control group (boys and girls, Hispanic and non-Hispanic, urban and rural), a bit of a Matthew Effect was hidden in the data. (A Matthew Effect is the phenomenon of accumulated advantage, in which the rich get richer and the poor get poorer.) Teachers were asked to rate their students in terms of low, medium, and high achievers; those whom the teachers had rated as low achievers gained less than those deemed high-achieving. If only low-achieving students were to receive SimCalc, they would catch up with their more advantaged peers, Roschelle predicted.

Another interesting finding was that a subpopulation of teachers with low math knowledge but strong pedagogy was able to connect with their students and produce gains in achievement and learning. The correlation between teacher content knowledge and student learning is not straightforward, nor is focusing on content knowledge alone sufficient, Roschelle noted.

### *Lessons Learned*

Since the initial study was conducted, its results have been replicated in other places and for additional learning principles.[9] Reflecting on what we can learn from these studies, Roschelle concluded that research *can* help to design more effective technology initiatives, but that the current research base and questions policy-makers most often ask are not well-aligned, and yield mixed or weak results. In Roschelle's view, the reliance on platform initiatives ("build the platform and great instruction will follow") or organic ones ("let a thousand flowers bloom and then spread the best results") is a deeply flawed approach.

> **"Learning activity systems or packages that integrate curriculum, technology, and professional development need to be offered in right-sized modules or chunks that are significant enough to deliver change, but modest enough that teachers feel they can try them and not feel overwhelmed."**
>
> Jeremy Roschelle

Returning to the design principles he had reviewed at the outset, Roschelle reiterated that the potential of going to scale provides an enduring reason to explore technology. In expecting and measuring real efficacy in teaching and learning, however, we must leverage what's unique about technology with proven learning principles. "Many of the things that are hawked aren't tied to learning principles," he said. "They may generate a lot of fun and excitement and are engaging, but how they actually change learning is unclear."

[9] Gladwell, Malcolm (2008-11-18). Outliers: The Story of Success (1 ed.). Little, Brown and Company. ISBN 0-316-01792-2.

The flip side, Roschelle continued, is that once we have something that produces an effect, do we also have something to measure it? Aligning measures to expected impact — as with the more sensitive test in the SimCalc example — remains a challenge.

Related to scale and effects is the implementation challenge of consistency. "It's very hard to get consistency if you rely on individual teachers to invent too much," Roschelle noted, because teachers will vary tremendously in terms of how good they will be at integrating new technology. Instead, we should be thinking about "learning activity systems" or packages that integrate curriculum, technology, and professional development. As with the SimCalc example, these need to be offered in right-sized modules or chunks that are significant enough to deliver change, but modest enough that teachers feel they can try them and not feel overwhelmed. They also need to be aligned with what school leaders are asking teachers to do. If so, they will have a much greater chance of success and sustainability.

> **"Many of the things that are hawked aren't tied to learning principles. They may generate a lot of fun and excitement and are engaging, but how they actually change learning is unclear."**
>
> Jeremy Roschelle

Finally, Roschelle concluded, to achieve equity goals, "We should be careful not to depend on an inequitably distributed resource: amazing teachers." Designing systems that make changes possible for all or most teachers, without jeopardizing their productivity, have the most potential.

## Facilitated Discussion

### *What does current research tell us about the quality and effect of digital teaching and learning platforms, tools, programs, and resources?*

Cal TAC members Jeff Bradbury and Heidi Haugen facilitated a discussion that turned quickly to the topic of professional development. As one participant pointed out, it is ironic that teachers are not accustomed to learning themselves — or to re-learning. "We get professional development all the time, but it's just delivered at us . . . we don't consistently go back and re-learn, because we don't get a chance to."

Others agreed that professional development generally is offered in a one-size-fits-all mode, without accommodating different levels of knowledge or learning styles. "If I did that [offered one-size-fits all teaching] in a classroom," one teacher noted, "I'd be considered a terrible teacher!"

What are potential solutions, given the resource constraints? One approach would be to look carefully at what can be learned from other systems — particularly workforce development and selected charter schools, which some felt may be doing a better job of aligning professional development with expectations for teachers and students.

Another suggestion was to explore interactive, online models. WestEd is launching online professional development connected to the CCSS, with a pilot of 109 teachers across 40 states. Although the concept of online-only professional development drew skepticism with many feeling that it would not be nearly as effective as face-to-face approaches, it might be an option for going to scale, given the upcoming changes that will be required from CCSS and NGSS. More widespread access to interactive, online professional development also may help avoid a "Matthew Effect" among teachers, where the best 10% keep improving but the majority does not. Anecdotal reactions from the initial cohort of 109 teachers have been positive, with some reporting it as the best professional development they've ever had.

Could the efficacy of DEE professional development be explored in a similar way? Given the current dissatisfaction with how professional development is delivered and the upcoming demands of the implementation of the CCSS, the moment may be right for innovation. In addition to ongoing professional development, a focus on pre-service training also will be key.

## Policy Updates

### *Barrett Snider, Partner and Lee Angela Reid, Senior Policy Advocate, Capitol Advisors Group*

Fresh from a late-night legislative session that had ended just a few hours before the Symposium began, Lee Angela Reid and Barrett Snider of Capitol Advisors Group provided an update on several education bills that could affect DEE resources and policies. Capitol Advisors Group represents a number of California school districts and County Offices of Education.

Although California, home to Silicon Valley, is a cutting-edge state, it has not embraced technology in its education system the way it could or should, Reid and Snider noted. In part, progress has been hindered by an attendance accounting system that counts "butts in seats," making it difficult to fit online classes and other changes into old funding formulas.

SB 185 (Walters)[10] allows school districts to negotiate prices for educational materials in K-8; secondary schools already can do this. It also allows for "unbundling," making it possible for districts to purchase components separately and to use digital formats throughout a district without paying for a separate license for each school.

Another major change is the new provisions of laws governing education funding under California's Local Control Funding Formula (LCFF). LCFF allows combining sources of funding for instructional materials and gifted and talented programs, leaving it up to local districts to determine how it will be spent — as long as plans for doing so are aligned with CCSS.[11] This offers many more opportunities for flexibility than in the past. A total of $1.25 billion is set aside for implementation of CCSS materials and professional

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10 http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB185.
11 http://www.cde.ca.gov/fg/aa/lc/lcffoverview.asp.

development; of this amount, about half ($622 million) has gone out to the districts. On a per-student basis, it's not a significant amount, given what needs to be done.

The first step is for districts to develop plans, but a larger issue is that of technology enhancement. Small school districts greeted the term "technology enhancement" with amusement. "How about technology in the first place, not to mention enhancement?" some have asked. Reid described schools that still don't have Internet access, or where teachers have to stand and face a certain direction in order to get phone service as examples of those who laughed at the idea of enhancement.

Questions about how to address requirements of the Williams Legislation (laws seeking to ensure that all students have equal access to the basics of a quality education: textbooks, instructional materials, safe and decent school facilities and qualified teachers) remain unanswered at this time. Will the provisions of the law continue to require districts to provide physical textbooks? Will access to identical content in a different format (e.g., from a home computer) fulfill the same requirements? This issue is still under review, with civil-rights groups part of the state policy conversation.

The more general issue of an emerging digital divide, especially for low-income students who lack access to technology at home, is related to requirements that school districts conduct computer-based assessments in English language arts and mathematics. AB 484 (Bonilla),[12] signed into law October 2, 2013, establishes the California Measurement of Academic Performance and Progress (CalMAPP) assessment system and replaces the Standardized Testing and Reporting (STAR) Program.[13] The primary purpose of the System is to "assist teachers, administrators, and pupils and their parents by promoting high-quality teaching and learning through the use of a variety of assessment approaches and item types."[14]

Could the development of these assessments be an opportunity for California, with business and government working together, to form a consortium to get schools wired in order to pave the way for more effective use of technology? (This would be an approach similar to producing relatively inexpensive copiers and printers — in order to create a market for toner cartridges.) According to the recommendations put forward by the Education Technology Task Force established by State Superintendent Tom Torlakson, collaborations between education and industry partners to form public-private programs should be encouraged.[15] The Task Force further recommended the creation of "modern, personalized assessments by providing essential technology, infrastructure, and professional development based on CCSS formative and summative computer adaptive assessments."[16]

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[12] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB484.

[13] Assembly Bill 484 Questions and Answers, California Department of Education, October 24, 2013; http://www.cde.ca.gov/ta/tg/sa/ab484qa.asp.

[14] Ibid.

[15] Education Technology Task Force Recommendations, August 2012, http://www.cde.ca.gov/eo/in/documents/efftmemo.pdf.

[16] Ibid.

As changes occur in what students learn, how academic progress is assessed, and how instructional materials are chosen and purchased, another issue is the interpretation of laws and restrictions (such as Williams Legislation). Since most districts interpret laws in a conservative way in order to avoid potential lawsuits, what guidance might be available to districts to encourage them to shift more rapidly to open-source and digital materials? In terms of waivers from the State Board of Education, Snider suggested, as long as the choices do not run afoul of labor or civil-rights groups, waivers are likely to be granted. In the meantime, purchasing digital materials as supplements is likely to be a safe route.

The Local Control Accountability Plans that are part of the LCFF (described above) are excellent opportunities for discussing these issues. "LCFF flexibility is the time to weigh in if you want to see more funds start to go to technology, professional development, and an equity focus as part of the local plans," one participant noted.

## From Leadership to Game Changing: The Future of Higher Education

### *Remarks by San Jose State University President Dr. Mohammad Qayoumi*

San Jose State University (SJSU) President Mohammad Qayoumi opened his talk with a startling observation, courtesy of the Public Policy Institute of California: for the first time in history, the percentage of younger adults (ages 25-34) with at least a Bachelor's degree will fall below the percentage of older adults (ages 55-64) who hold these degrees.[17] The lower educational attainment among the younger generation, compared to that of their parents, is a national phenomenon, Qayoumi explained. It is driven in part by the drastically increasing costs of higher education and the sense, as earning power has fallen, that higher education is not worth the investment.

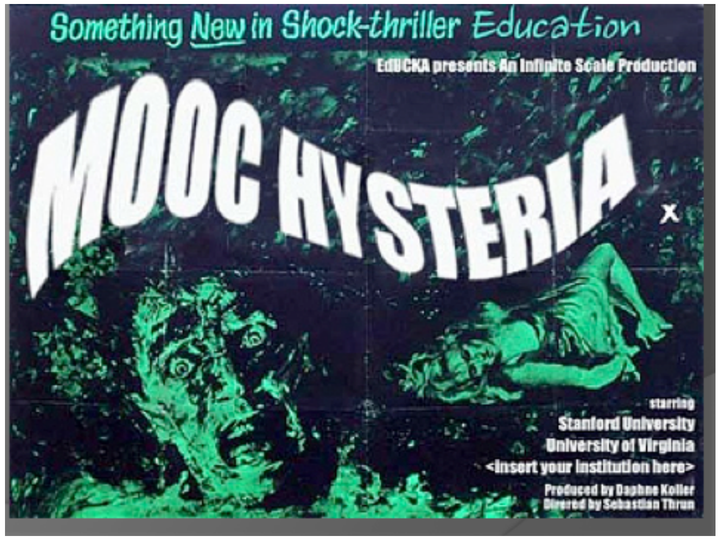
Qayoumi described the forces shaping this reality as "tectonic shifts." We now have more cell phones than toothbrushes. Globally, about 76% of people have access to electricity, which has been around since 1900. Yet 81% of the world's population has access to a mobile device.[18] This connectivity moves us from a scarcity of knowledge to almost unimaginable abundance — a flood of video and data in which the human voice and conversation accounts for a small proportion of the traffic.

In this hyper-connected world, Qayoumi observed, citizenship is redefined. Individuals no longer want to be passive listeners; they want to participate actively as creators as well as consumers of information. In this new world, self-organized systems and assessments flourish — from Twitter and flash mobs to the Arab Spring. We must become accustomed, Qayoumi said, to a more logarithmic rather than a linear scale — and to see the role of technology as a transformative force.

17 http://www.ppic.org.

18 http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html.

For higher education, the adjustment to this transformed world and culture is a challenge. "We have to get beyond solving problems," Qayoumi observed "because that limits us to existing paradigms. How could we look instead at ways of imagining new possibilities?"




One way is to look at how technology has transformed aspects of life that would have seemed unimaginable just a few years ago. Amazon — an Internet platform — has changed the way people buy things. Facebook — a people platform — has changed how people relate to each other. Tablet platforms (e.g., Apple's iPad) and information platforms (Google) have changed the pace, volume, and mobility of information, creating an "Internet of Everything." And collectively, all of these changes have pushed education to be "green, global, and mobile."

This is the backdrop for the recent development of Massive Open Online Courses (MOOCs). This rapidly expanding approach has strong Bay Area connections — not only to the companies offering MOOCs (e.g., Coursera, Khan Academy, and Udacity) and to local universities, but also to venture-capital firms and nonprofits.

SJSU's MOOC experience began in the summer of 2012, when faculty went to MIT to observe how a flipped/blended course worked. In the fall 2012, SJSU piloted a flipped/blended course in one section of an electrical-engineering course, using the first MIT edX course.[19] Outside of class, students watched edX video lectures and completed quizzes, labs, and textbook reviews; inside class, they concentrated on small-group work and quizzes, with instructors interacting with students for questions for a portion of the time.

The edX course piloted last fall was Circuits and Electronics, a gateway course for engineering majors at SJSU; they must receive a grade of C or higher to be able to stay in engineering. Traditionally, the passing rates were between 55 and 59%, meaning that at least 41% of students had to take the course again. In the online version, 91% received passing grades. Similar results were achieved in the spring, leading to a collaborative Center for Excellence in Adaptive and Online Learning between SJSU and edX and an expansion to other edX courses.

Encouraged by these results, SJSU then collaborated with Udacity to develop three courses, focusing on those that pose the greatest challenges for students: remedial math,

[19] https://www.edx.org/school/mitx/allcourses.

introductory Algebra, and statistics courses. The courses are developed by SJSU's faculty members, who then own the intellectual property.

The courses were offered at $150 (comparable to community college fees) for those seeking credit and did not require textbook purchases, which often can exceed this level of tuition costs. The SJSU course-development costs were about $15,000 per course; Udacity covered the rest of the costs (between $50,000-$100,000 per course). Qayoumi noted that the idea for these pilots was to cover expenses and then split revenues between SJSU and Udacity (with 51% to SJSU and 49% to Udacity). Ultimately, he said, the goal is to not lose money, rather than earning a lot in revenues. The costs need to be kept reasonable to give larger numbers of students access.

In addition to enrolling SJSU students, the courses were open to Oakland high-school students and others, and were widely available at no cost for those not seeking credit. A total of 228 students in the math, algebra, and statistics courses offered in the spring of 2013 and 1,261 students in courses offered in the summer of 2013 (including the three math, algebra, and statistics courses as well as computer programming and psychology). In addition to these students who enrolled for credit, 94,000 students enrolled in the MOOC courses for free.

The table below shows the results of the SJSU/Udacity MOOC pilot, representing students who earned a C or better in these courses in the spring pilot, the summer pilot, and in an average of traditional on-campus versions of the courses offered for the past six semesters.

**Percent of Students Earning C Grade of Higher**

| | *Spring Pilot 2013* | *Summer Pilot 2013* | *SJSU On-Campus (based on past 6 semesters)* |
|---|---|---|---|
| **Elementary Statistics** | 50.5% | 83.0% | 76.3% |
| **College Algebra** | 25.4% | 72.6% | 64.7% |
| **Entry Level Math** | 23.8% | 29.8% | 45.5% |
| **General Psychology** | not offered | 67.3% | 83.0% |
| **Intro to Programming** | not offered | 70.4% | 67.6% |

Because the team had access to over 100 data points for each student, they had a wealth of information on how students spent their time (e.g., on videos, practice exercises and questions). They made several adjustments along the way, including adding orientation sessions so that students would know more about what's expected of them, and communicating with students via text instead of e-mail (or at least texting them to prompt them to read an e-mail).

A key finding was that the more time students spent being engaged, the more likely they were to succeed. For remedial math in particular, the stakes are high: nationally, 1.5 million students take remedial math; the savings for the CSU system and the state as a whole would be considerable if students could take such courses while still in high school.

The courses were not repeated in the fall as the team regrouped to further assess the content and delivery of the courses. While this was portrayed as a failure in some media accounts, Qayoumi said, among those who were most disappointed were the faculty, who were enthused and eager to move forward.

> **"The more time students spent being engaged, the more likely they were to succeed."**
>
> Mohammad Qayoumi, President
> San Jose State University

Far from being discouraged, Qayoumi sees MOOCs as a tremendous opportunity for new learning pathways and access to learning, in which students could access remedial and other lower-division courses through the Cloud, and then access material from a wide variety of sources to engage in upper-division course work. Through course work, research, service learning, and other mechanisms, students could be more connected to a campus, not only during their educational tenure, but also as lifelong learners. For example, alumni could have free access to MOOC courses as part of their annual alumni association membership. In this model, learning would be free; only those who need credits would pay a fee.

"We need to move from traditional models to new learning ecosystems," Qayoumi concluded. "We need to move from disengaged individuals to extreme learners, from assigning homework to enticing with content, from lecture halls to collaboratoria, and from grades to continuous feedback."

New technologies are an important tool in this transformation, Qayoumi said — perhaps even a weapon. "Let's use technology as a weapon for mass instruction!"

## The Efficacy of Digital Teaching and Learning: Implications for Facilitating the Implementation of the Common Core State Standards

### *Sarah Gilman, Common Core Technology Project, Los Angeles Unified School District*

Sarah Gilman, content developer and administrator for the Los Angeles Unified School District's (LAUSD) Common Core Technology Project, described the LAUSD experiences deploying iPads to 47 schools in the first phase of a program that was designed to eventually spread district-wide. The goal was to increase collaboration among students, teachers, administrators, families and schools.

Before joining the Common Core Technology Project at LAUSD, Gilman was a fifth-grade teacher on the staff at Melrose STEAM (STEM, plus Arts) Magnet program. Melrose is an Apple Distinguished School with a one-to-one laptop implementation program, in which each student receives a laptop pre-loaded with grade-level textbooks, software, and other tools for 24/7 learning.

In addition to the iPad deployment, the Melrose School was also introducing robotics, pedagogical shifts in mathematics, and other changes — so the increases in creativity, collaboration, and innovation are not attributable to any one aspect of the new approaches.

Gilman noted the dramatic increases in test scores and identified four key elements she believes contributed to the program's success:

- Ongoing teacher professional development;
- Parent education classes;
- Support for both instruction and technology; and
- Building a school culture that supports risk-taking and innovation (perhaps the most important).

Reflecting on the success of the Melrose program, Gilman also credited the school's principal, who recognized that what they were doing initially was not working. They invested a great deal of time and effort in doing research and visiting other schools, sitting in classrooms to see what worked and having many conversations with teachers.

In her new role at the Common Core Technology Project, Gilman is exploring ways to take Melrose's experience to more schools across the district. The project team is working to build the capacity of principals as instructional leaders, encouraging them to take risks themselves to implement technology and to model this for teachers. Further, her team is listening carefully to what principals and teachers say is critical to successful implementation of the iPad initiative. For example, in response to surveys about the type of professional development teachers need, most wanted in-person training from a colleague at school, or face-to-face professional development. Only 11% of survey respondents were interested in online professional development — a relatively low percentage. Gilman and her colleagues know that professional development will be key as they expand first to 47 schools and eventually to hundreds more. She also added a caution that while the team will try to offer as much face-to-face professional development as possible, it may not be realistic to do so on that scale (across 700 schools and the entire district).

### *Dr. Mary Vixie Sandy, Executive Director, California Commission on Teacher Credentialing (CTC)*

> **"In both pre-service programs and ongoing professional development, we need to create learning ecosystems that are self-perpetuating, with teachers coming to the environment prepared to act and be agents of teaching and learning."**
>
> Mary Vixie Sandy

Dr. Vixie Sandy addressed the implications of digital teaching and learning for licensure and how teachers can be supported as they begin their practice. What we really need, she said, is more innovative instructional practices — and technology is a tool to advance that goal.

Of course we want teachers to be innovators; they can't teach and not be innovators. But relying on teachers' own initiative as the primary driver to make changes introduces too many inconsistencies and is probably insufficient, Vixie Sandy said. Yet we also don't want to simply frontload teachers with materials and strategies for a digital curriculum and expect them to follow a recipe; that too is not the best strategy for innovation and certainly will not serve us well in the CCSS scenario.

A hybrid model, in which teachers receive materials but also have specific training and support for developing instructional practices using digital materials, seems the most likely way to improve the interaction between teachers and students. Indeed, Vixie Sandy said, "It's the quality of interaction that distinguishes good teachers from bad or not-so-good teachers." In this regard, the five design principles enumerated by Jeremy Roschelle (see page 9) would be a useful framework to consider, she added.

In both pre-service programs and ongoing professional development, we need to create learning ecosystems that are self-perpetuating, with teachers coming to the environment prepared to act and be agents of teaching and learning.

> **"It's a good time for us to be thinking at the state level about setting expectations and supporting the kinds of [technology related] changes we're trying to make."**
>
> Mary Vixie Sandy

How could this be accomplished? Historically, Vixie Sandy said, the CTC's standards around technology have been weak, treating technology as an afterthought. Some teacher-preparation programs have been able to integrate technology more thoroughly and usefully, but the variation in teacher-preparation programs is as wide as the variation in classroom practice. Another factor is the placement of student teachers. If student teachers could be placed in the classrooms of highly accomplished, tech-savvy teachers such as those described by Cal TAC members, Vixie Sandy noted, they would be far more prepared to adapt to a digital teaching and learning environment.

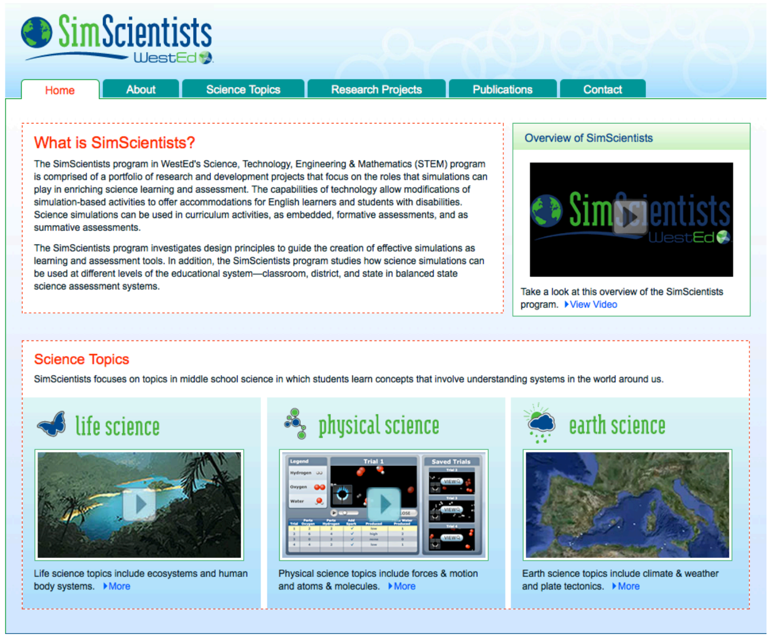
In closing, Vixie Sandy noted that the CTC is working this year on standards for principals, administrators, and teachers. A goal is to shift from thinking about technology as an add-on, and towards a more integrated understanding of what is possible. She urged the Symposium participants to engage in this process. "It's a good time for us to be thinking at the state level about setting expectations and supporting the kinds of [technology-related] changes we're trying to make," she concluded.

### *Dr. Steve Schneider, Senior Program Director of the Science, Technology, Engineering and Mathematics Program, WestEd*

Dr. Schneider reviewed some challenges posed by the CCSS as well as overviews of cognitive-science learning principles, meaningful research designs, and current research.

Schneider encouraged Symposium participants to view existing digital-education resources with a dose of skepticism. "Just because everyone is doing it," he cautioned, "doesn't mean it works."

The convergence of CCSS and NGSS marks a return to teaching across the curriculum, Schneider noted, but the real challenges lie in teaching differently — engaging students, prompting a sense of inquiry, giving students tools to provide evidence to their arguments and organizing their thoughts and questions. As we move forward with implementation of the standards, Schneider said, these practices will be a challenge to everyone, across the curriculum.




Schneider noted that numerous practice guides have been developed and compiled, but they are far more "state of the shelf" than state of the art, and remain largely unused. But in reviewing research on cognition and learning in math and science, Schneider continued, it's difficult to find research that explains what works. In part, it's because a criterion for including research studies is the rigor of the research design — not the outcome of whether or not the practices actually work.

Instead of serving as productivity tools that make reporting easier or show right or wrong answers, digitally enhanced materials should help students actually work through a problem, understanding why an answer was incorrect and how their reasoning could lead to a different result. A related issue is the way that some digital resources (as well as textbooks) use graphics in ways that are distracting rather than illuminating.

> **"Digitally enhanced materials should help students actually work through a problem, understanding why an answer was incorrect and how their reasoning could lead to a different result."**
>
> Steve Schneider, Senior Program Director of the Science, Technology, Engineering and Mathematics Program, WestEd

One area where the digital world offers great potential is in the use of formative assessments. Among other virtues, these ongoing assessments give teachers valuable information about where their students' understanding may have gone awry, while there is still time and opportunity to fix it — rather than waiting until the end of the semester or curriculum.

WestEd's SimScientists software [20] is an example of applying formative assessment design principles to middle-school science concepts, offering a portfolio of projects that use simulations to model complex science systems. The program is designed to prompt authentic, problem-based inquiry and builds in feedback and scaffolding principles, as well as reflection activities to foster collaborative learning and practice with scientific reasoning and argument.

[20] http://www.simscientists.org/home/index.php.

What are some features of meaningful research designs? Schneider reviewed six principles for scientific inquiry set forth by the National Research Council in 2002:

1. Pose significant questions that can be investigated empirically.
2. Link research to relevant theory.
3. Use methods that permit direct investigation of the question.
4. Provide a coherent, explicit chain of reasoning.
5. Replicate and generalize across studies.
6. Disclose research to encourage professional scrutiny and critique.[21]

Studies need not be randomized control trials, but should align with a study design that matches a given research purpose. For example, qualitative or mixed methods would be preferred approaches for research that explores or describes digital tools, rather than quantitative methods, which would be more appropriate for studies designed to predict or explain outcomes.

In assessing blended learning environments, the implementation context should be taken into account. For example, researchers should seek to understand what types of institutional supports are in place (such as teacher training, as well as hardware and software), the teacher's skill level (particularly in terms of technology and data), and more details about students (such as their motivation to use hybrid/blended learning and how they actually use these systems).

WestEd is currently studying two approaches related to DEE: individual tutoring using intelligent tutoring systems (including Quantum, AnimalWatch, and Voyage to Galapagos), and Connected Classroom Technology (CCT), which is interactive educational technology to support formative assessment and teacher-student interactions. Additional studies are underway of Carnegie Mellon's Open Learning Initiative, the Cognitive Tutor Study, Khan Academy (pilots that showed no statistically significant improvement for students using Khan programs compared to the control group),[22] and Rocketship (which significantly changed its learning lab model in response to pilot data, giving teachers a more prominent role).

Schneider cited several Web sites where more information on the reports and studies he described can be obtained. They include:

- Change the Equation (www.changetheequation.org), a CEO-led initiative to improve the quality of STEM learning in the United States, with a database of STEM programs (STEMworks).
- National Assessment Governing Board (www.nagb.org), where a link to the *Technology and Engineering Literacy Framework for the 2014 National Assessment of Educational Progress* can be found under the "Publications" tab.

21 National Research Council. 2002. *Research in Education.*
22 http://www.blendmylearning.com/2011/08/31/the-results/.

- EdSurge article on changes to the Rocketship model (https://www.edsurge.com/n/2013-07-24-changes-to-rocketship-s-learning-lab-puts-teachers-in-driver-s-seat).
- Khan Academy in Los Altos School District (http://www.khanacademy.org/about/blog/post/10243685407/impact-from-using-khan-academy).

Overall, it is disappointing that the studies carried out to date show little if no improvements in student learning. As we move forward, can we derive some general principles from such results that stimulate redesigns of both curricula and pedagogy?

## Concluding Discussion and Next Steps

To conclude the Symposium and reflection on the information presented by the speakers, Beth Graybill, Chief Deputy Executive Director of the California Commission on Teacher Credentialing (CTC), facilitated a discussion. This discussion focused on our current understanding of the efficacy of DEE and how we might expand this understanding moving forward. Below are some of the responses of Symposium participants to these questions:

- **Secure Evaluation/Research Resources:** The SimCalc study described by Jeremy Roschelle cost $6 million. Identifying resources for studies on this scale is a formidable challenge; what can be done in the meantime (with assistance from higher education and government funding) is to do more of these types of studies locally.
- **Note What Doesn't Work:** Many of the presentations noted that substantial resources are being devoted to things that don't work, such as platform initiatives. In addition to a common understanding of what works, should we also be developing a common understanding of what doesn't work?
- **Pair Innovation with Research:** We should "marry" innovation and experience with research at every step.
- **Identify What Works, for Whom:** DEE has a significant role to play not only in children's learning, but also in adult learning. It may be that the Khan Academy interactions, for example, are more beneficial for older learners. But this underscores the point that we have a world of diverse learners and teachers, as well as differences among age groups, and we need to understand what works for each of them.
- **Promote Engagement:** Whether it's in a workforce environment or in a school setting, engagement appears to be a precursor to learning. DEE is a way to increase the likelihood of engagement when it might not occur otherwise. Yet engagement is not enough: we need to focus also on what it takes to make lifelong, self-directed learners who reflect about their own learning, even among the youngest students. It's a digital divide as well as a learning divide in the sense of how students think of themselves as learners, and that is where digital materials have potential.

- Technology, artfully developed and appropriately targeted to meet individual needs, might also serve to engage teachers in professional development (from which many are disengaged).
- If we want teachers to innovate, we need to make it safe for them to do so. An approach that brings teachers together with their peers to design lessons together (similar to past California Project Math Institutes[23] that gave teachers stipends to do this together over the summer) would be one way to improve DEE applications in the classroom.

- **Increase Sophistication of Evaluation Tools and Questions:** Our evaluation tools and questions are starting to move to a higher level of sophistication. Are we asking students the right questions (e.g., with Common Core Mathematics, Common Core English Language Arts and NGSS)? Are we asking appropriately detailed questions about platforms, tools, which students, what outcomes? The NGSS will require a whole different line of inquiry and new types of research — e.g., beyond content knowledge, how might DEE strengthen students' ability to represent and model concepts in math?
- **Highlight the Critical Role of Professional Development in the Successful Implementation of Digital Teaching and Learning:** The NGSS will require a great deal from teachers; it's critical that the state offer guidance to them. A related issue is the role of principals in supporting teachers.
- **Focus on Mastery — A Model A Ford vs. a Learjet:** Technology takes us places we couldn't go before, but we're trying to judge the Learjet version by Model A standards. Technology allows us to go from the seat-time model of learning to a mastery model, but both funding and assessments have to catch up.

In her closing remarks, Susan Hackwood echoed these themes, noting that they are reminders that the group is grappling with an emerging phenomenon. The Symposium, by design, brings together thought partners strategically placed within California's education and policy communities. "If we've done our jobs," Hackwood said, "you'll take this back to your worlds and continue the conversation . . . but it won't be just one conversation."

[23] http://www.cmpso.org.

## Appendix A: Symposium Participants

**Efficacy of Digitally Enhanced Education in California Symposium II**
September 13, 2013
California Department of Education

# Council Chair and Vice Chair

**Brian Shay**
Mathematics Teacher
Canyon Crest Academy and Cal TAC Chair

**Heidi Haugen**
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**Camille Esch**
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**Sarah Gilman**
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**Beth Graybill**
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**Mohammad Qayoumi**
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Congressman George Miller

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**Chris Roe**
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**Nicole Lezin**
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**Sandra Vargas**
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California Council on Science and
Technology

**Julie Meier Wright**
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