

DIGITALLY ENHANCED EDUCATION: A RESOURCE GUIDE FOR LEARNERS AND LEADERS



California Council on Science and Technology

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Digitally Enhanced Education:

A Resource Guide for Learners and Leaders

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Preface

In 2010, The California Council on Science and Technology (CCST), a nonpartisan, nonprofit 501(c) (3) established via Assembly Concurrent Resolution in 1988, was asked by a bipartisan group of California Legislators to “assess the state’s innovation ‘ecosystem’ and offer a specific list of recommendations for legislators to enhance the state’s ability to foster and benefit from innovation.”¹ Two major areas, education and water, were identified as major challenges where the solutions could enhance California’s international competitiveness.^{2,3} Subsequently, CCST, along with its Teacher Advisory Council (Cal TAC), a group of award-winning STEM teachers from across the state, began their examination of digitally enhanced education (DEE) in California’s public schools in 2012, focusing specifically on the efficacy of digital teaching and learning, namely what works well, for whom and under what circumstances.

As part of the report to the legislature on this rapidly expanding field, CCST and Cal TAC have developed the following ***Resource Guide*** comprised of samples of DEE-related leadership documents and references that can serve as sources of information for members of the policy, education, business, and philanthropic communities as they work together to shape, nurture, and support technology’s increasing role in student learning. The elements in this guide are based on the expertise of other states, local districts, and education support organizations that have led the way in integrating technology into instruction. In the spirit of the Open Education Resource (OER), the sample guidelines, frameworks, assessments and other materials are offered to those with interests in pursuing informed policies and practices to guide the use of technology in the classroom, in after school environments, and in informal learning settings.

Recognizing that the work of CCST, Cal TAC and others to encourage the exploration of the efficacy of digital teaching and learning is in its infancy, we consider this *Resource Guide* to be organic and iterative – a snapshot in time along a continuum; we invite others to add to this resource bank as the DEE field evolves and matures. While we want to encourage inclusion based on forward-thinking and creative vision, what we have learned about the efficacy of digital teaching and learning must also guide selection and application of these resources. For this reason, we include in the introduction to the *Resource Guide* a short summary of research elements most likely to serve as sound and reliable references to efficacious practices with respect to digital teaching and learning. In addition to the introduction, the *Resource Guide* consists of the following categories:

¹ Innovate 2 Innovation – An Assessment of California’s Innovation Ecosystem (Phase I); CCST; February 2011

² Innovate 2 Innovation – An Assessment of California’s Innovation Ecosystem (Phase II) Digitally Enhanced Education; CCST; August 2011

³ Innovate 2 Innovation – An Assessment of California’s Innovation Ecosystem (Phase II) California’s Water Future; CCST; August 2011

- Sample Leadership and Framing Documents;
- Standards, Frameworks, and Guides for Digitally Enhanced Education
- Assessing the Efficacy of DEE-related platforms, tools, programs and resources;
- Leadership Organizations; and
- Recommendations for Use

At the time this report was first commissioned in 2011, there was very little focus on DEE. Yet in the short span of three years, the entrants into this rapidly growing field are many and diverse. We are grateful for the guidance we have received from those who are leaders in the field and others knowledgeable about DEE.

Introduction

In 2010, at the behest of a bipartisan group of California legislators, the California Teacher Advisory (Cal TAC) and its parent organization, the California Council on Science and Technology Council California (CCST) began to explore the innovation capacity of the state and in particular the status of digitally enhanced education (DEE)⁴. While technology was advancing rapidly in business and industry, it was unclear if or how digital teaching and learning was taking hold in California schools. Providing guidance and structure for this look at technology's role in education was a CCST report entitled *Innovate 2 Innovation - An Assessment of California's Innovation Ecosystem (Phase II) Digitally Enhanced Education*.⁵ The early exploration of the "if and how" of DEE rested on the premise that:

The digital age has affected students' learning, memory, attention and social relationships. Children and youth of this digital generation are defined by their technology and media use, their love of social connectivity through electronic communication, and their need to multitask. They enjoy access to unprecedented volumes of news and information around the clock. Their access to and use of digital technologies is not a fad, but a paradigm shift in how they access and use information...the digital age has particularly far-reaching implications for education, and that California needs to implement a 21st century learning environment that reflects the ubiquitous presence of technology and fully utilizes the tools, competencies, and innovation that have become part and parcel of daily life⁶.

Studies on which the digitalization of education must rely should be designed to detect meaningful effects, emphasizing unique features of technology connected to proven learning principles, while looking at an entire package of integrated curriculum, technology, professional development, and assessment.

– California Teacher Advisory Council Members

⁴ Innovate 2 Innovation – An Assessment of California's Innovation Ecosystem (Phase I); CCST; February 2011
<http://www.ccst.us/publications/2011/2011i2i.php>

⁵ Innovate 2 Innovation – An Assessment of California's Innovation Ecosystem (Phase II) Digitally Enhanced Education; CCST; August 2011

⁶ Ibid, p. 1

This report outlined four “foundational pillars” upon which the transformation from incubation to innovation in education would rest, including:

- The classroom environment
- The teacher
- The institutional infrastructure
- The partnerships

Despite the allure to embed digital teaching and learning quickly into every classroom, it was deemed wise to take a careful look at the extent to which DEE was fulfilling the promise of access, increased engagement, and higher achievement for students. Cal TAC members believed that to move forward responsibly, more must be done to provide sound and reliable data to inform decision making in support of *effective* digitally enhanced education.

Using these first two documents as a base, over the next two years, members of Cal TAC hosted two symposia and produced five reports^{7,8,9,10,11} examining both the status of digitally enhanced education and its efficacy by answering key questions:

- 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? and,
- What education policies need to be in place to maximize these opportunities and ensure their equitable distribution across schools and systems?

The research fell short in guiding policy in terms of telling us what works in general, or guiding instructional decision-making by teachers in the classroom.

⁷ Proceedings documents from each of the symposia are available on the CCST website at <https://www.ccst.us/publications/index.php> and include. Digitally Enhanced Education in California: Summary of the California Teacher Advisory (Cal TAC) Workshop on Using Digital Media to Improve Teaching and Learning (July 2-12)

⁸ Digitally Enhanced Education in California: Educational Technology and Digital Media Use in California's Teacher Preparation Programs - A Status Report (August 2012)

⁹ Digitally Enhanced Education in California: Creating a Vision for Integrating Digital Media into California's Teacher Preparation System (October 2012)

¹⁰ Assessing the Effects of Digitally Enhanced Education: Summary of Symposium Discussions (September 2013)

¹¹ The Efficacy of Digitally Enhanced Education: Summary of Symposium Discussions (March 20, 2014)

These symposia yielded a complex and rapidly changing picture of the role of technology in education, and exposed a wide gap between expectations for technology use in the classroom, and disappointing results from studies of the effects of these technologies on teaching and learning. Given the significant attention on DEE over the last few years, it was surprising to learn that the strongest research fell into limited areas articulating learning theories, curricular design frameworks, approaches to teacher professional development, and assessment designs. However, the research fell “short in guiding policy in terms of telling us what works in general, or guiding instructional decision-making by teachers in the classroom.”

In a recent nation-wide survey, 74% of teachers noted that educational technology is a student motivator, with online lesson plans, web-based interactive games, and web sites to deliver class information emerging as the top three most commonly used tech resources.

It has become increasingly clear that members of the education leadership, business, policy and philanthropic communities need to gather more information on the efficacy of digitally enhanced education in order to shape policies and practice throughout the state. As technology continues its rapid integration into instruction, Dr. Jeremy Roschelle, Co-director of the Center for

Technology in Learning at SRI International, offers five research-based characteristics of studies that are most likely to detect meaningful effects. They:

- Emphasize unique features of technology that are connected to a proven principle of learning;
- Focus on how technology helps teachers convey something that is hard for them to teach, and/or for students to learn, in “right-sized” segments. Individual lessons would be too small to create a measurable change, while a year-long change might be too ambitious;
- Integrate curriculum, technology, professional development, and assessment. The entire package is important;
- Emphasize teacher productivity and alignment, i.e., 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; and
- Measure what matters. Currently, tests are too blunt or misdirected to truly measure the kinds of changes we’d like to see, including better alignment between what we test and what we want to know.¹²

¹² Ibid; p. 9.

With the growing numbers of teachers and students embracing educational technologies, states and local districts are under increasing pressure to provide support and guidance in the selection, use and evaluation of these digitally enhanced resources. Teachers, however, are not waiting for the tools they need to enhance and extend their students' learning, and are already ahead of policy makers and education leadership in embracing educational technology. For example, in a recent nation-wide survey, 74% of teachers noted that educational technology is a student motivator, with online lesson plans, web-based interactive games, and web sites to deliver class information emerging as the top three most commonly used tech resources.¹³

In addition to the resources listed in the following pages, Cal TAC has prepared a practical QUICK Assessment, shown in Appendix A. Intended as a checklist for teachers when considering DEE material, the assessment's "My Rating" column provides teachers the opportunity to assign digital tools and materials a numeric rating allowing them to rapidly determine the efficacy of digital media. The QUICK Assessment and the resources listed in this Resource Guide are just a small sample of what has become available to assist teachers, and school and district leadership as they explore and adopt the educational technologies that will help prepare students for success in college, careers, and civic life.

¹³ PBS Learning Media; Teacher Technology Usage; VeraQuest; 2013
<http://www.infodocket.com/2013/02/04/survey-looks-at-technology-usage-by-teachers-in-the-classroom/>

Sample Leadership Organizations

A substantial increase in the number of digitally enhanced education support organizations has paralleled the exponential growth in use of technology in classrooms, afterschool programs, and informal settings across the country. They range in focus from assisting teachers as they incorporate technology into everyday classroom life, to helping principals and district administrators make reasoned decisions about how to invest scarce education funds wisely, to providing venues for members of the policy and education leadership communities to discuss the changing education landscape and the policies and practices that will enable students to thrive academically. Some are membership-based, others operate from state and federal agencies, and still others provide assistance through research entities, such as regional labs, college campuses, and non-profit research organizations. Throughout our examination of efficacy in digital teaching and learning the leadership and staff of many of the organizations listed below have given generously of their time and counsel in the open network spirit. This list represents a small segment of this growing community as other support providers emerge across the country every day.

<i>Example Leadership Organizations</i>	
Organization	Summary and Contact Information
The California Educational Technology Professionals Association	<p>CETPA is a non-profit membership organization, comprised of Educational Technology Professionals (technologists) who support schools in California and outlying areas. Founded in 1960, the association has dedicated more than 50 years of service toward activities that aim to improve the public education system with a strong emphasis on Administrative Information Processing within the State of California. The organization fosters a spirit of innovation and professional development in its membership and strives to better the public education system with ongoing support to members and meet the technological needs of the Instructional Program.</p> <p>http://www.cetpa-k12.org/</p> <p>Andrea Bennett Executive Director 915 L Street #C424 Sacramento, CA 95814 andrea.bennett@cetpa.net</p>

California Technology Assistance Program	<p>The California Technology Assistance Project (CTAP) is a statewide educational technology leadership initiative, providing assistance to schools and districts in integrating technology into teaching and learning.</p> <p>Funded by the Education Technology Local Assistance Program, CTAP focuses on promoting the effective use of educational technology through regional coordination of educational support services based on local needs. Each of the eleven county superintendents' regions in the state has developed and is implementing a plan to provide technology assistance in five key component areas: staff development, technical assistance, information and learning resources, telecommunications infrastructure and coordination and funding. (http://www.clrn.org/links/ctap.cfm)</p> <p>Each region is in charge of the implementation of the program.</p>
California Technology Student Association	<p>CA TSA was founded in 2001 and is a movement whose aim is to empower Middle School and High School students to learn more about the technical world, grow as leaders and explore opportunities beyond the classical classroom setting. (http://www.californiatlsa.org/)</p> <p>Rachel Newell – California TSA State Advisor 484-437-2255 CaliforniatSA@gmail.com</p>
Computer Using Educators (CUE)	<p>CUE is a nonprofit educational corporation founded in 1978. CUE's goal is to advance student achievement through technology in all disciplines from preschool through college. With an active current membership of thousands of educational professionals, CUE supports many regional affiliates and special interest groups. CUE is the largest organization of its type in the west and one of the largest in the United States. (http://www.cue.org/)</p> <p>Mike Lawrence Executive Director Mlawrence.cue.org (925) 478-3461</p>

<p>International Technological Engineering Educators Association [Engineering By Design, a standards-based model program in the STEM disciplines]</p>	<p>The International Technology and Engineering Educators Association's STEM Center for Teaching and Learning™ has developed a standards-based national model for Grades K-12 that delivers technological literacy in a STEM context. The model, Engineering By Design (EdB), is built on the Common Core State Standards, Standards for Technological Literacy (ITEEA), Principles and Standards for School Mathematics (NCTM), and Project 2061, Benchmarks for Science Literacy (AAAS). The goals of EdB are to:</p> <ul style="list-style-type: none"> • Provide a standards-based K-12 program that ensures that all students are technologically literate, • Provide opportunities for all students without regard to gender or ethnic origin, • Provide clear standards and expectations for increasing student achievement in science, technology, engineering and mathematics, • Provide leadership and support that will produce continuous improvement and innovation in the program, • Restore America's status as the leader in innovation, and • Provide a program that constructs learning from a very early age and culminates in a capstone experience that leads students to become the next generation of engineers, technologists, innovators, and designers. <p>(http://www.iteea.org/EbD/ebd.htm)</p> <p>Steven A. Barbato, DTE Executive Director (703) 860-2100 sbarbato@iteea.org</p>
<p>National Center for Technological Literacy, Museum of Science, Boston University</p>	<p>The National Center for Technological Literacy has been helping to educate children and adults in a variety of educational settings since 2004. This Museum of Science, Boston initiative is active nationwide via partnerships that seek to raise awareness and understanding of engineering in schools and museums. One of the goals of the NCTL is to inspire and foster the next generation of engineers and technology leaders by promoting technology and engineering understanding. (http://legacy.mos.org/nctl/index.php)</p> <p>Ioannis N. Miaoulis President and Director</p>

<p>The National Research Council (NRC)</p>	<p>As the operating arm of the National Academy of Sciences, the National Academy of Engineering, and the Institutes of Medicine, the National Research Council's mission is to improve government decision making and public policy, increase public understanding, and promote the acquisition and dissemination of knowledge in matters involving science, engineering, technology, and health. NRC's independent, expert reports and other scientific activities inform policies and actions that have the power to improve the lives of people in the U.S. and around the world.</p> <p>The NRC performs its studies and workshops through six major divisions: Behavioral and Social Sciences and Education, Earth and Life Studies, Engineering and Physical Sciences, Policy and Global Affairs, Transportation Research Board, and the Gulf Research Program.</p> <p>(http://www.nationalacademies.org/nrc/index.html)</p> <p>National Research Council Bruce B. Darling, Executive Officer bdarling@nas.edu</p>
<p>Project Lead The Way (PLTW)</p>	<p>PLTW is a nonprofit 501(c)(3) organization that delivers programs to more than 5,000 elementary, middle, and high schools in all 50 states and the District of Columbia. PLTW programs use the following considerations:</p> <ul style="list-style-type: none"> • Collaboration: Seeks ongoing input and feedback from students, teachers, administrators, and subject matter experts. The work is informed by current research and guidance by experts in academic and industry sectors. • Research/Evidence-Based: Follows Wiggins and McTighe's approach, Understanding by Design®, to develop a cohesive and coherent instructional path for students. • Problem-Based: Design- activity-, project-, and problem-based experiences to prepare students to solve problems. This approach creates scaffolding for student learning and provides the rigor and relevance that engages and empowers students. <p>(https://www.pltw.org/)</p> <p>Dr. Vince Bertram President and CEO vbertram@pltw.org</p> <p>Robin Schott Vice President, West Central Region rschott@pltw.org</p>

State Educational Technology Director's Association (SETDA): A Guide to Technology Requirements - Beyond Technology Readiness for Testing: Planning for Teaching, Learning and Assessment	<p>Founded in 2001, the State Educational Technology Directors Association (SETDA) is the principal nonprofit membership association representing U.S. state and territorial educational technology leaders. The mission is to build and increase the capacity of state and national leaders to improve education through technology policy and practice. SETDA strongly encourages education policymakers and leaders to undertake a proactive systems approach to addressing school technology needs for the long-term—explicitly considering the present and future technology needs to meet curricular, instructional, assessment, professional learning and school operations goals and providing a framework for addressing critical questions for different nested dependencies of readiness.</p> <p>http://gtr.setda.org/guidance/#!/overview</p> <p>Doug Levin Executive Director (202) 715-6636 x 700</p>
TechNet	<p>In 1997, a group of Silicon Valley visionaries including John Doerr, Jim Barksdale and John Chambers recognized the technology industry's need for a bridge to policymakers. They created a CEO-led organization to engage with Washington, DC and state capitals across the country with an aim to educate government leaders on the importance of the growing technology industry and to promote a technology-led innovation ecosystem.</p> <p>TechNet takes on critical issues that impact members like Microsoft, Cisco, Google, Oracle, Facebook, Apple and other industry titans as well as some of the nation's most dynamic start-ups. Under the direction of its highly positioned membership, TechNet is now a strong fundraising network and effective policy advocacy organization with an impact on federal and state policy issues critical to U.S. innovation and economic competitiveness. (http://www.technet.org/about/who-we-are/)</p> <p>John Doherty Vice President, State Policy & Politics and General Counsel 1001 K Street, 6th Floor Sacramento, CA 95814 (916) 594-7987</p>
Technology Information Center for Administrative Leadership	<p>The Technology Information Center for Administrative Leadership (TICAL) was formed by the California Department of Education (CDE) which commissioned the Santa Cruz County Office of Education to develop a centralized repository of technology-related resources and professional development opportunities for California's administrators.</p> <p>http://www.portical.org/</p> <p>Rowland Baker Executive Director (831) 419.5335</p>

<p>U.S. Department of Education, Office of Educational Technology</p>	<p>The Office of Educational Technology (OET), in the Office of the Secretary, provides leadership for transforming education through the power of technology. OET develops national educational technology policy and advocates for the transition from print-based to digital learning. OET supports the President’s and Secretary’s ConnectED Initiative by promoting equity of access, by ensuring a device for every learner, connecting all schools to broadband internet, and supporting powered-up educators and a robust ecosystem of entrepreneurs and innovators. (http://www.ed.gov/edblogs/technology/)</p> <p>Richard Culatta Director LBJ Education Building, 5W114 (202) 453-6381</p>
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Sample Leadership and Framing Documents

In an introduction to the PACE Policy Brief, *Education Technology Policy for a 21st Century Learning System*, Dr. Charles Kerchner observed, “Educational technology has always overpromised and under delivered.”¹⁴ In this statement, we believe that Kerchner sets up a special challenge for California, a state that has slipped well behind others in the U.S. in its adoption and use of technology in the classroom:

“The potential of technology and the inertia of the existing institutions produce an exquisite public policy face-off. Technology will continue to develop even if the state does nothing at all. Computers, tablets, smartphones, and thousands of apps will continue to appear. Existing vendors will jockey to incorporate technology into the products they sell, and of course sew up proprietary rights as they do so. Venture capitalists will continue to fund applications that look promising. A robust industry of inventors and developers will create new curricula, entire instructional systems, software for managing educational talent, and for aggregating and analyzing data.

How should public policy respond?”¹⁵

How does California, with its large and diverse student population of well over six million students, 300,000 teachers, and nearly 10,000 schools begin to catch up? How do policy makers, education leaders, parents and other interested citizens make sense of digitally enhanced education, a field that is expanding and changing at a remarkable speed? How should they navigate the flood of education technology-related research papers, policy briefs, and articles carried by technical journals and the popular press to get to sound and reliable advice on how to proceed?

“Educational technology has always overpromised and under delivered.”

– Dr. Charles Kerchner, Research Professor, Claremont Graduate University

CCST and Cal TAC established as a base for the symposia series a set of documents that focused on the efficacy of digital teaching and learning from an empirical perspective. These leadership documents represented varying points of view on teaching and learning, as well as looking at DEE from a perspective of those both inside and outside of public education.

¹⁴ Kerchner, Charles T.; *Education technology Policy for a 21st Century Learning System*; PACE; March 2013; p. 1.

¹⁵ *Ibid*, p. 3.

The short list of readings below is offered as a start for the development of a larger library of writings that illuminate answers to the questions posed earlier in this Guide:

- 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? and
- What education policies need to be in place to maximize these opportunities and ensure their equitable distribution across schools and systems?

Example Leadership and Framing Documents		
Organization	Document Title	Summary
The Babson Survey Research Group and the Quahog Research Group	<i>Changing Course: Ten Years of Tracking On-line Education in the U.S.</i>	The <i>Changing Course: Ten Years of Tracking Online Education in the United States</i> was the tenth annual report on the state of online learning in the U.S. higher education aimed at tracking the opinions of chief academic officers and answering fundamental questions about the nature and extent of online education. This study addressed Massive Open Online Courses (MOOCs), which may have changed the perception higher education leaders have of MOOCs and other online classes. (http://www.onlinelearningsurvey.com/reports/changingcourse.pdf)
CCST California Teacher Advisory Council	<i>Digitally Enhanced Education in California, Volume 1: Digital Education Programs</i>	In May 2012, CCST published <i>Digitally Enhanced Education in California, Volume 1: Digital Education Programs</i> , as the first part of two-step examination of the state's current digital education "ecosystem." This report was written in response to a request from a bi-partisan group of California legislators asking for an assessment of the state's innovation ecosystem. The report also includes recommendations for creating a set of technology related policies to guide the development of an education technology infrastructure. (https://www.ccst.us/publications/2012/2012digital-1.pdf)
CCST California Teacher Advisory Council	<i>Digitally Enhanced Education in California, Volume 2: Education Codes and Administrative Codes of Governing Regulations</i>	<i>Digitally Enhanced Education in California, Volume 2: Education Codes and Administrative Codes of Governing Regulations</i> (May, 2012) examined the statutory and regulatory requirements governing California's use and applications of digital education for teaching and learning in K-12 schools. The report also identified the regulatory barriers that limit broad adoption of digital tools and networks both within and outside traditional classroom-based instruction. (https://www.ccst.us/publications/2012/2012digital-2.pdf)

The Center For Public Education	<i>Searching for the Reality of Virtual Schools</i>	<p>In response to the amount of digital information Americans consume every day and because digital content in public education is inevitable, in May 2012, the Center for Public Education published a report describing the variety of ways in which digital learning is offered to students. In addition to summarizing various methods of digital learning, the report examines the current state and district policies that govern its administration as well as what is known and not known about the effects online learning has on student outcomes. Finally, the report identifies a list of questions for policymakers to ask when considering policies to expand online learning.</p> <p>(http://www.centerforpubliceducation.org/Main-Menu/Organizing-a-school/Searching-for-the-reality-of-virtual-schools-at-a-glance/Searching-for-the-reality-of-virtual-schools-full-report.pdf)</p>
Education Development Center, Inc.; Gender, Diversities and Technology Institute	<i>Effective Access: Teachers' use of digital resources in STEM teaching</i>	<p>The Gender, Diversities, and Technology Institute at the Education Development Center, Inc. released a report culminating three years of research on STEM educators' use of digital resources. The report focused on high school STEM educators as an important and broad subset.</p> <p>(http://www2.edc.org/gdi/publications_sr/effectiveaccessreport.pdf)</p>
Organisation for Economic Co-operation and Development	<i>Connected Minds: Technology and Today's Learners</i>	<p>Authored by Francesco Pedro and produced by the OECD's Centre for Education Research and Innovation (CERI) with support from the MacArthur Foundation, <i>Connected Minds: Technology and Today's Learners</i> was the final report of OECD's <i>New Millennium Learners (NML)</i> project. The report outlined the importance of connectedness and the benefit that connectedness can provide in relation to personal, social, work and economic purposes. The report also concludes that there is "not enough research evidence to demonstrate that technology connectedness has critical effects on cognitive skills development." (http://www.keepeek.com/Digital-Asset-Management/oecd/education/connected-minds_9789264111011-en#page1)</p>

Policy Analysis for California Education	<i>Education Technology Policy for 21st Century Learning Systems</i>	<p>The <i>Education Technology Policy for 21st Century Learning Systems</i> policy brief was published in May 2013 by research professor Charles Taylor Kerchner from Claremont Graduate University. In the report, Kerchner focused on three ways that internet-related technology could alter the learning production system. First, internet-related technology can be used to implement an individualized learning system that has the capacity to match an instructional style with the student's needs. Second, adaptive software could be used to respond to a student's needs while also providing feedback to teachers. And lastly, internet-related technology has the capacity to open production of learning to groups of teachers, small enterprises, and individuals changing, learning production from its "traditional hierarchy." Kerchner also identified policy changes that can be adopted to take advantage of what he calls "Learning 2.0".</p> <p>(http://www.edpolicyinca.org/sites/default/files/PACE Policy Brief 13-3.pdf)</p>
The U.S. Department of Education	<i>Understanding the Implications of Online Learning for Education Productivity</i>	<p>In January 2012, the report, <i>Understanding the Implications of Online Learning for Education Productivity</i>, was developed for the U.S. Department of Education to provide support for education administrators and policymakers in becoming informed consumers of information about online learning and its potential impact on education. The purpose of the report was to provide the knowledge needed to understand and further examine the potential productivity contributions of online learning and to review the research online learning might offer productivity benefits compared to traditional schooling.</p> <p>(http://www2.ed.gov/about/offices/list/ose/technology/implications-online-learning.pdf)</p>

Sample National, State and Local Frameworks and Standards for Practice

A Nation At Risk, the landmark education reform document released in 1983, included in its recommendations a call for the development of standards and expectations that would guard against grade inflation and serve as a platform for new, higher expectations for students' learning. An admonition to consider "the most current applications of technology in appropriate curriculum areas"¹⁶ was among the recommendations, providing a base - and encouragement - for the development of standards for what students and their teachers should know and be able to do in the arena of digitally enhanced education. Some thirty years later, standards for digital teaching and learning are more commonly appearing in states across the country. In addition to student and teacher standards, frameworks intended to guide policy are also emerging at the national, state and local levels.

<i>Example Frameworks and Standards of Practice</i>	
Organization	Summary
Education Technology Standards for Connecticut	In March 2012, the Connecticut State Department of Education published revised standards for Technology Education in Connecticut, based on nationally recognized standards including Pathways to College and Career Readiness, Career Clusters and ITEEA Technology Literacy Standards. The Connecticut Technology Education Standards are divided into two levels, 6-8 and 9-12. http://www.sde.ct.gov/sde/lib/sde/pdf/deps/career/TE_Standards_09_12.pdf
The International Society for Technology in Education National Standards:	The International Society for Technology in Education (ISTE) offers free resources to help teachers and administrators learn about the ISTE Standards and how to use them. ISTE developed the ISTE Standards (formerly known as the NETS) with input from the field and pioneered their use among educators. The ISTE Standards are the standards for learning, teaching and leading in the digital age. (https://www.iste.org/standards)
ISTE Standards for Teachers	ISTE Standards for Teachers sets forward the skills and knowledge educators needed to teach, work and learn in an increasingly connected global and digital society: <ul style="list-style-type: none"> • ISTE Standards•T (PDF) • Essential Conditions (PDF) • ISTE Standards•T (2000) (PDF)

¹⁶ A Nation At Risk: The Imperative for Educational Reform, A Report To The Nation And The Secretary Of Education; The National Commission on Excellence in Education, April 1983.

ISTE Standards for Students	<ul style="list-style-type: none"> • ISTE Standards•S (PDF) • ISTE Standards•S Profiles (PDF) • Essential Conditions (PDF) • ISTE Standards Implementation Wiki • ISTE Standards•S (1998) (PDF) • Translated ISTE Standards (PDF)
ISTE Standards for Administrators	<p>ISTE Standards for Administrators, resource to help administrators learn about the ISTE Standards and how to use them.</p> <ul style="list-style-type: none"> • ISTE Standards•A (PDF) • Essential Conditions (PDF) • ISTE Standards•A (2002) (PDF)
ISTE Standards for Coaches	<p>ISTE Standards for Coaches resources are designed to help education coaches learn about the ISTE Standards and how to use them.</p> <ul style="list-style-type: none"> • ISTE Standards•C (PDF) • Coaching White Paper
ISTE Essential Conditions	<p>ISTE Essential Conditions, those conditions necessary to effectively leverage technology for learning. (https://www.iste.org/standards/essential-conditions)</p>
The Maryland State Technology Literacy Standards for Students	<p>In April 2007, the State Board of Education accepted the Maryland Education Technology Plan for the New Millennium: 2007-2012. With this acceptance, Maryland had new technology literacy standards for students, teachers and administrators, defining the standards of what each group needs to know and to do using technology. (http://mdk12.org/instruction/curriculum/technology_literacy/vsc_technology_literacy_standards.pdf)</p>
The National Education Technology Plan	<p>The National Education Technology Plan, <i>Transforming American Education: Learning Powered by Technology</i>, “calls for applying the advanced technologies used in our daily personal and professional lives to our entire education system to improve student learning, accelerate and scale up the adoption of effective practices, and use data and information for continuous improvement.” It puts forward five overarching goals accompanied by recommendations for states, districts, the federal government, and other stakeholders.” The goals address Learning, Assessment, Teaching, Infrastructure, and Productivity. (http://www.ed.gov/technology/netp-2010)</p>
The National Standards for Quality Online Teaching V2	<p>In 2008, the International Association for K-12 Online Learning (iNACOL) organized a committee of experts from education organizations with an interest in online education to review existing online teaching quality standards. They then developed a cross-reference of standards, followed by a survey completed by representatives of the iNACOL network to ensure the efficacy of the standards adopted. iNACOL then endorsed the Standards for Quality Online Teaching and Online Teaching Evaluation for State Virtual Schools as a comprehensive set of criteria. (Version 1 dated 2008)</p> <p>iNACOL organized another team of experts to review new standards and the new literature on the topic. The team determined that there was a need to refresh Version 1 of the iNACOL standards. Using the same process, Version 2 was developed with newer standards. (Version 2 dated 2011). (http://www.inacol.org/cms/wp-content/uploads/2013/02/iNACOL_TeachingStandardsv2.pdf)</p>

The Standards for Technological Literacy: Content for the Study of Technology	<p>The International Technology Association provides “an essential core of technological knowledge and skills” for K-12 students. The standards and accompanying benchmarks were designed to be age appropriate and build an “increasingly sophisticated understanding and ability as students mature.” (http://www.iteaconnect.org/TAA/PDFs/xstnd.pdf)</p>
The Washington State Education Technology Standards	<p>The standards for educational technology are designed for all K-12 schools and reflect grade-level expectations for digital technologies. Each standard is accompanied by classroom activities that feature learning environments where “technology is abundant” as well as those using very little technology.</p> <p>Technology Literacy is the ability to responsibly, creatively and effectively use appropriate technology to:</p> <ul style="list-style-type: none"> • Communicate. • Access, collect, manage, integrate and evaluate information. • Solve problems and create solutions • Build and share knowledge. • Improve and enhance learning in all subject areas and experiences. <p>Technology Fluency is demonstrated when students:</p> <ul style="list-style-type: none"> • Apply technology to real-world experiences. • Adapt to changing technologies. • Modify current and create new technologies. • Personalize technology to meet personal needs, interests and learning style. <p>(http://www.k12.wa.us/EdTech/Standards/pubdocs/K-12-EdTech-Standards_12-2008b.pdf)</p>

Assessing the Efficacy of DEE-related Platforms, Tools, Programs and Resources

The evaluation of the efficacy of educational technology in classrooms, after-school programs, and informal settings has not yet begun to catch up with the rapid expansion of digital teaching and learning. The research to date has relied largely on anecdotal record rather than empirical data, and is strongest in enumerating various learning theories, curricular design frameworks, approaches to teacher professional development, and assessment designs. 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.¹⁷ Currently, DEE has yielded some isolated success stories, but since implementation is not yet at scale, these individual effects are insufficient to reach conclusions. “Technology may be doing something, but the test we have isn’t equipped to measure it.”¹⁸

“Technology may be doing something, but the test we have isn’t equipped to measure it.”

–Dr. Jeremy Roschelle, Co-director of the Center for Technology in Learning at SRI International

Despite its slow start and a cautious approach to the use of empirical data, assessment of the effect of the digitalization of education on students is catching on across the globe. Approaches range from the assessment of broad programs such as cyber schools and approaches like blended learning, to applications, tools, platforms, and other resources. Teachers have emerged as particularly significant sources of information as the data they are now able to gather on the effect of the use of educational technology on their students is often and easily shared between and among practitioners, as well as with for-profit and nonprofit educational technology organizations. Information now can be gleaned from data elements as small as the time between keystrokes on a web-based test and housed on an individual laptop or a university assessment and evaluation center. The challenge, however, is to mine this information in appropriate and useful ways, analyze the data accurately, report findings in an unbiased manner and in a way that facilitates its use by members of the policy and education communities, and leads to improvements in the technologies that facilitate students’ learning.

¹⁷ Rochelle, Jeremy; Symposium on the Efficacy of Digitally Enhanced Education; Sacramento, California; September 2013.

¹⁸ Ibid

Example Organizations and Documents		
Organization	Title	Summary
ACT	<i>Evaluating the Effectiveness of Technology In Our Schools</i>	<p>This policy report, published in 2004, provides a view of the issues concerning the effectiveness of technology in its role to enhance education. This report's audience is educational leaders and policymakers who are concerned with making optimal use of technology in the schools.</p> <p>(http://www.act.org/research/policymakers/pdf/school_tech.pdf)</p>
The California Council on Science and Technology	<i>Assessing the Effects of Digitally Enhanced Education: Summary of Symposium Discussions</i>	<p>In 2012 and 2013, the California Council on Science and Technology's (CCST) California Teacher Advisory Council hosted a series of symposia aimed at addressing the effect of digitally enhanced education on students and their teachers. <i>Assessing the Effects of Digitally Enhanced Education: Summary of Symposium Discussions</i> summarizes the discussion of the May 2013 symposium, which took place at the University of California, Davis. This symposium explored how the effect of DEE can and should be measured, and identified specific policy and practice issues regarding its implementation.</p> <p>(http://www.ccst.us/publications/2013/2013digital.pdf)</p>
The Center for Public Education	<i>Searching for the Reality of Virtual Schools</i>	<p>In response to the amount of digital information Americans consume every day and because digital content in public education is inevitable, in May 2012, the Center for Public Education published a report describing the variety of ways in which digital learning is offered to students. In addition to examining the methods of digital learning, the report examined the current state and district policies that govern its administration as well as what is known and not known about the effects online learning has on student outcomes. The report also identified a list of questions for policymakers to ask when considering policies to expand online learning.</p> <p>(http://www.centerforpubliceducation.org/Main-Menu/Organizing-a-school/Searching-for-the-reality-of-virtual-schools-at-a-glance/Searching-for-the-reality-of-virtual-schools-full-report.pdf)</p>

The National Education Policy Center	<i>Virtual Schools in the U.S. 2013: Politics, Performance, Policy, and Research Evidence</i>	<p>The <i>Virtual Schools in the U.S. 2013: Politics, Performance, Policy, and Research Evidence</i> was the first of a series of planned annual reports from the National Education Policy Center to provide an objective analysis of the performance of full-time, publicly funded K-12 virtual schools. The report has three sections, which 1) presented research on the size, scope and performance of full-time K-12 virtual schools, 2) identified unaddressed policy issues related to virtual schools, and, 3) focused on claims made about virtual technologies. (http://nepc.colorado.edu/files/nepc-virtual-2013.pdf)</p>
The U. S. Department of Education Office of Technology	<i>Expanding Evidence Approaches For Learning In A Digital World</i>	<p>Published by the Office of Educational Technology, this report combines views of education researchers, technology developers, educators and researchers in merging fields. Calling for change by educators, policymakers and funders, the report encourage technology developers, educators and researchers to collaborate to accelerate progress and ensuring innovation in education. (http://www.ed.gov/edblogs/technology/files/2013/02/Expanding-Evidence-Approaches.pdf)</p>

Summary and Recommendations for Use

This educational technology Resource Guide was designed for use by members of the

Digitally enhanced education (DEE) has arrived in California's classrooms, "but its scope, implementation, and impact have not been evenly distributed, systematically tallied and researched, or well understood."

*– The Efficacy of Digitally Enhanced Education:
Summary of Symposium Discussions*

policy, education, and philanthropic communities as they work toward applying new technologies to strengthen students' learning. As resources were gathered, it became clear that the amount of information coming into classrooms, schools and

informal settings was staggering, with very few screens available to help users sift and sort through the mountain of material. Moreover, the pace at which new Open Education Resources (OER), applications, and other technology-related resources are becoming available changes the education landscape rapidly: what initially appeared to be powerful tools for learning disappeared overnight with multiple new, and potentially useful, products crowding in to take their place. School districts invested scarce discretionary dollars for the services of companies that rose quickly then faded just as fast. Digitally enhanced education (DEE) has arrived in California's classrooms, "but its scope, implementation, and impact have not been evenly distributed, systematically tallied and researched, or well understood."¹⁹

Because there was little empirical data or evidence-based guidance about what works, for whom, and under which conditions, the California Teacher Advisory Council began its examination of the efficacy of digitally enhanced education by identifying organizations that were known and respected for their sound, empirical research on educational technology policy and practice. Cal TAC convened two symposia where policy makers, teachers, school and district administrators, foundation staff, and business leaders came together to learn more about the status of digitally enhanced education from these experts, as well as to review and discuss the latest research on its impact on teaching practice and student learning.

¹⁹ The Efficacy of Digitally Enhanced Education: Summary of Symposium Discussions; The California Council on Science and Technology; Riverside, CA; 2013; p. 1.

Developments from the Cal TAC symposia:

- The Digital Age is rapidly and unevenly coming of age in classrooms across California with little support for teachers or students when compared to other states;
- Too little is known about digitally enhanced education with regard to
 - What works, why and for whom;
 - The contexts and circumstances that can either hinder or enhance digital modes of teaching and learning; and
 - Those education policies that must be in place to make the most of these opportunities and ensure their equitable distribution across schools and systems.
- Today, teaching practice and students' learning is being transformed by technology in ways unimagined even five years ago, and limited only by our imagination of what will be possible five years hence.

The California Council on Science and Technology and the California Teacher Advisory Council join with other education support organizations that are calling, first and foremost, for a statewide plan for the development, implementation and support of an educational technology infrastructure that addresses issues of equity, and ensures that each and every student has access to digital resources that will enable him or her to be fully prepared for college, career and civic life. Toward that end we propose for consideration the following recommendations for ensuring California's students have the opportunity to take full advantage of all that educational technology has to offer:

- Look carefully at high-quality, sound and reliable data to guide decision-making. We believe California's students and their teachers will be better served if the following review criteria are considered as education policy and practice are developed:
 - 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-learning and who are economically disadvantaged. Further, include the extent to which there is access for all to tools, software, on-line resources, and support as well as the ways in which students engage with and use these technologies;

- Marry innovation with research at every step in implementing DEE alongside the Common Core and Next Generation Science Standards. The convergence of Common Core and Next Generation Science Standards with the new technologies presents real challenges to the ways teachers teach and students learn (engaging students, prompting a sense of inquiry, giving students tools to provide evidence to their arguments and organizing their thoughts and questions). Program planning strategies that take into consideration the following key implementation elements are essential, including:
 - Equipment,
 - Tech support,
 - Professional development, and
 - Adequate planning time.
 - 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; and
 - 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.²⁰
- Ensure an adequate knowledge of the status and the promise of educational technology before rushing to construct statewide standards; support pilot programs that enable decision makers to systematically learn from successful attempts as well as failures²¹.
 - Consider technology within the context of a different learning ecosystem that “stands on the shoulders of the century-old model courses and classes. Learning 1.0, but does not destroy it.”²² We agree with Dr. Charles Taylor Kerchner who offers the following policy advice that promises substantial leverage:
 - **Invest** in technological solutions to real and persistent problems in public schools - technology applications where the benefits, challenges, and returns to investment can be readily and concretely shown;
 - **Create** an educational infrastructure for California’s students, teachers, and schools - a collection of networked resources that adapt with use, continually improving and redesigning; and

²⁰ Ibid; p.4

²¹ Lezin, N.; Assessing the Effect of Digitally Enhanced Education; Summary of Discussion at a California Teachers Advisory (Cal TAC) Symposium; May, 2013; p.4.

²² Ibid; p. 4

- **Modify** regulations to create better incentives and fewer barriers to using technology without losing the safeguards that regulation is intended to provide - an easing of rules that encourages experimentation and integration of technology in existing school districts.²³

Technology, like other new tools introduced into the learning environment, has attracted supporters and detractors. However, technology is decidedly different, both in terms of its ubiquitousness and the scale and speed of change. No longer do we have the luxury of “Moore’s Law’s 18 month cycle.” Unlike the state and locally adopted resources available currently, the new entrants often come to the education community without adequate evaluation. Further the inequitable access to and distribution of resources across the state makes it incumbent upon California policymakers to provide framework for digitally enhanced education that will enable students to lead in innovation and achievement. This framework must be realistic in terms of resources and, most importantly, include approaches to teacher development that lead to effective implementation in the classroom.

This Resource Guide is a start. It is a living document meant to change as the efficacy of digitally enhanced education in California evolves. CCST and Cal TAC stand committed to continue this work through partnerships and collaborations regionally, state-wide, and nation-wide with the goal of broadly disseminating best practices in STEM teaching and learning environments throughout the state.

²³ Kerchner, Charles T.; Education technology Policy for a 21st Century Learning System; PACE; March 2013; pgs. 11

Appendix A: *QUICK* Assessment For Educational Digital Resources

QUICK Assessment For Educational Digital Resources		
PRINCIPLE	EVIDENCE	My RATING
Q UALITY OF THE RESOURCE	The resource: <ul style="list-style-type: none"> • Is valid and reliable • Functions as described • Is well designed, easy to use, and works properly • Provides materials that are comprehensive and easy to understand 	
U SER-FRIENDLY	The material: <ul style="list-style-type: none"> • Is accessible to all students • Offers a variety of ways for students to use the materials • Has a range of cognitive demands appropriate for my students 	
I NTEREST OF STUDENT CAPTURED AND MAINTAINED	The material: <ul style="list-style-type: none"> • Holds my students' interest • Invites creativity and innovation • Encourages self-direction 	
C CSS & NEXT GENERATION SCIENCE STANDARDS (NGSS) ALIGNMENT	<ul style="list-style-type: none"> • The material directly addresses the content and practices of the CCSS and NGSS standards • Assessments are clearly aligned to CCSS/NGSS performance expectations 	
K NOWLEDGE AND SKILLS CONTENT	The content: <ul style="list-style-type: none"> • Is purposeful and directly related to my students' learning • Promotes deeper thinking, understanding, and reasoning • Is engaging, clearly written and accurate • Clearly identifies the main ideas and purpose of the lesson 	

RATING SCALE:

California Council on Science and Technology's (CCST) Cal TAC QUICK Assessment was designed as a tool for teachers who wish to rapidly assess the potential of a digital resource. Some may wish to indicate the extent to which the resource addresses the Principles and Evidence by making a simple check or other mark while others may be more comfortable with a scoring rubric such as:

- 3: Excellent potential
- 2: Solid potential in most areas
- 1: Mixed potential
- 0: Little or no potential

There is no single way to use the QUICK. We encourage teachers to experiment with this tool and its rating strategy to discover what works best for them.

QUICK Assessment For Educational Digital Resources

- Educational technologies are entering our education systems at a remarkably fast pace, and thousands of teachers are often left on their own to decide which, if any, digital resources will effectively enhance instruction and advance their students' learning.
- To address this need, members of the California Council on Science and Technology's (CCST) California Teacher Advisory Council (Cal TAC) offer this tool for teachers and other educators to help guide the selection of appropriate digitally enhanced resources.
- It is not meant to take the place of more comprehensive assessment systems for evaluating the effectiveness of digital platforms, apps, and resources, but rather provides a "quick" screen of *prospective* quality and utility of educational technology in a classroom, afterschool, or informal setting.
- Whether planning lessons, working directly with students, or in some other learning context, we hope that applying the Quick Assessment will help educators navigate this rapidly expanding area of the education landscape.
- This tool was developed with input from many classroom teachers who have tested the criteria in varying contexts; we anticipate continuing refinements will be added as its use spreads.

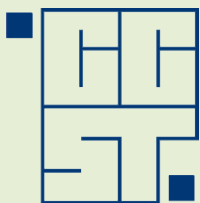
For those looking for ways in which to look more deeply at the effect of digital resources, many more sources are beginning to emerge. For example, please see the Rubrics for Evaluating Open Education Resources (OER) Objects (Achieve: www.Achieve.org), Graphite (Common Sense Media: www.graphite.org), and CLRN (California Learning Resource Network: www.clrn.org).

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QUICK Assessment for Education Digital Resources



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 catalyzes leading experts in science and technology to engage with decision-makers with the goal to ensure California's continued leadership in science, technology, innovation, and science education. As a part of CCST, Cal TAC is a group of outstanding K-14 science and math classroom teachers that provides a voice for the STEM educator community, involving teachers in discussions of education related policy. Cal TAC produces studies and makes recommendations on issues important to STEM education and interfaces directly with teachers and policy makers.



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Appendix B: California Teacher Advisory Council Members

Cal TAC Members

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Science Teacher
Florin High School

Andrew (Andy) Kotko (Vice-Chair)
First-Grade Teacher
Mather Heights Elementary

Carol Berberich
Mathematics Teacher
Culver City Middle School

Jeff Bradbury
Chemistry Professor
Cerritos Community College

Marilyn Garza
Physical Science Teacher
Santa Barbara Junior High School

Darrel James
Biological Science Teacher
Fred C. Beyer High School

Susan Kunze
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Elm Street Elementary School

Arthur Lopez
Computer Science Teacher
Sweetwater High School

Roy Mason
Environmental Science Teacher
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Jennifer Santos
Kindergarten Teacher
Miraloma Elementary School

Osvaldo Soto
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Patrick Henry High School

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