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POLICY BRIEF

MAY 2013

Education Technology Policy for a 21st Century Learning System

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Policy Brief 13-3

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Educational technology has always overpromised and under delivered. Every technological innovation, from student workbooks in the 1920s to television in the 1950s, was accompanied by the prediction that it would revolutionize teaching and learning. All these predictions proved wrong.[1]

The learning production system that technology tries to alter has proven remarkably long lasting, and for a simple reason. For more than a century, no one has found a more efficient system for teaching children than putting a teacher in front of 30 students in a classroom, unless it was to add more students. The phrase "the grammar of schooling" enshrines the basic teaching technology: students are divided into grades, each with its expectations. There are standard subjects that become separate courses by the high school level. Courses last for set periods of time, and a student's credit, a teacher's pay, and a school's finances are all tied to the delivery of these courses.[2]

Schools usually equate technology adoption with buying computers and wiring buildings. Buying technology makes boards and superintendents look modern and legitimately progressive. Buying technology responds to questions about preparing students for

Executive Summary

Internet-related technology has the capacity to change the learning production system in three important ways. First, it creates the capacity to move from the existing batch processing system of teaching and learning to a much more individualized learning system capable of matching instructional style and pace to a student's needs.

Second, technology can help make the learning system smart. Adaptive software responds to student activity, providing options, assistance, and challenges. It can also provide feedback to teachers, allowing them to intervene and adjust.

Third, Internet-based technology has the capacity to switch learning production from its traditional hierarchy to a much more open network. Currently, the official curriculum, along with associated lessons and tests, flows from a small oligopoly of publishers whose actions are guided by a handful of large states and school districts. The economies of scale inherent in curriculum packaging concentrate political and economic advantage and reinforce the tendency toward "one

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Executive Summary (Cont.)

best system" and one-size-fits-all solutions. The network capacity of the Internet opens the production of learning to groups of teachers, small enterprises, and individuals.

In this policy brief Charles Taylor Kerchner argues that California has an opportunity to take the lead in harnessing digital technologies and online resources to dramatically improve the performance of the state's schools and students. He identifies key policy changes that the state can adopt to take full advantage of the promise of what he calls Learning 2.0.

the 21st century and global competition. Yet, technology is almost always crammed into the existing system.

Because technology has largely been subject to the existing production system, it has been, at most, a valuable adjunct. A student can use a computer in the back of the classroom to review or drill. Fresh information from the web can be brought into a class discussion. But often, computers are simply delivered to classrooms, and teachers are left to integrate them into their pedagogy, similar to adding a sand table to a kindergarten. To teachers, technology is often a maddening complication, an unwelcome intrusion.

Joel Rose, who had been an elementary school teacher in Houston before starting the School of One in New York City, recalled his teaching days after someone from the district delivered three computers to his classroom: "Three kids are on the computer; I'm working with 24…one kid finished early he wants to come in…the other two are hitting each other…I got them to stop…one kid said he was absent yesterday and he missed his turn…can he go back? It made my job harder. We've taken this technology and cascaded it on the teachers."[3]

Until now. This time it could be different.

Internet-related technology has the capacity to change the learning production system in three important ways. First, it creates the capacity to move from the existing batch processing system to a much more individualized learning system capable of matching learning style and pace to a student's needs. At the School of One in New York City, each student gets a "playlist" every day: a schedule built on their previous day's work and the student's learning styles. Depending on the playlist, a student may spend time in group lessons, tutorials, or working alone with one of the 5,000 lesson segments that the school's developers have selected from publishers and software developers.

Second, technology can help make the learning system smart. Adaptive software responds to student activity, providing options, assistance, and challenges. It can also provide feedback to teachers, allowing them to intervene and adjust. It is becoming more sophisticated, and is being developed by firms such as Dreambox (in which former State School Board president Reed Hastings has invested), Headsprout, Knewton, Grockit, Carnegie Learning, and others. Adaptive technology is also being built into the new assessments being developed by the SMARTER Balanced Assessment Consortium (SBAC) that California joined to complement the Common Core State Standards.

Third, Internet-based technology has the capacity to switch learning production from its traditional hierarchy to a much more open network. Currently, the official curriculum, along with associated lessons and tests, flows from a small oligopoly of publishers whose actions are guided by a handful of large states and school districts. The economies of scale inherent in curriculum packaging concentrate political and economic advantage and reinforce the tendency toward "one best system" and one-size-fits-all solutions. The network capacity of the Internet opens the production of learning to groups of teachers, small enterprises, and individuals, such as Salman Khan, whose electronic chalkboard lessons for his niece gave rise to the free-access Khan Academy.

Network capacity also enables peer production collaboratives, such as those that support the classroom management system Moodle or the curriculum development project Curriki. In each of these cases the capacity to create is matched by the capacity of users to critique and modify. Social sharing and exchange allow groups of teachers and others to create educational materials—Flexbooks are a good example—that rival the effectiveness of

those created by conventional publishers. As the capacity for adaptive software increases, opportunity for peer production of educational materials will increase also.

The network capacity of the Internet supports student collaboration, allowing youngsters to work and learn together on projects and in virtual study groups with access to experts anywhere in the world. Educators have known for decades that student study groups were powerful motivators and achievement boosters. The Internet extends this capacity and in so doing increases the capacity for social learning.

In *Disrupting Class*, Clayton Christensen, Michael Horn, and Curtis Johnson argue that the Internet is an inherently disruptive technology, that education will follow the path of other industries, and that schools will flip into Internet-driven learning all on their own. But there are signs that the institutional inertia in public education may, once again, be stronger than the force of technology.[4]

A Difficult Public Policy Arena

The potential of technology and the inertia of 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, and software for managing educational talent and aggregating and analyzing data.

How should public policy respond? California has a strong interest in making public education efficient and productive, but it has seldom explicitly used technology to pursue that interest. It has a strong interest in educational equity, both in access and in outcomes, and it has a strong interest in keeping the system open to innovations created outside school districts while preventing vendors from capturing the curricular and pedagogical core.

The state has a considerable interest in technology policies that make learning work better in areas of education that are relatively expensive, where success has been difficult to achieve, and where greater efficiencies could be realized if the parts of the system worked together. With the right technology policies, these are achievable goals. Thus, the approach advocated here combines a big picture view of capacity—building a new learning system—with the application of technology to some of public education's persistent achievement problems.

I have studied schools where people think outside the conventions of the century-old acquisition and storage model of learning and where learning is organized in unconventional ways, providing a glimpse of what a new learning system might look like. At High Tech High in San Diego, New Tech at Jefferson High School in Los Angeles, and the Avalon School in Minnesota, students learn by designing and completing projects. All these schools make extensive use of technology in pursuit of their distinctive learning systems. Parents who enroll their children in the California Virtual Academy link them to a highly structured curriculum and online support. As demonstrated at Los Angeles Unified School District's technology fair, hands-on learning motivates students, some of whom have been "ganged up" and lost to any form of schooling, to recreate themselves as designers and graphic artists. At Rocketship, Claremont High School, and other schools, blended learning—"clicks and bricks"— brings together technology and face-to-face experiences using Moodle and other software. Games, simulations, apps, and the burgeoning world of open lectures and courses grow daily. Scotland has invested in the world's first national education intranet, Glow, which can link every student, classroom, teacher, and family in the country.

I have synthesized the lessons from these and other schools into what I call *Learning 2.0*, the next full scale upgrade of learning production. Like well-designed software, it stands on the shoulders of the century-old model courses and classes, Learning 1.0, but does not destroy it. The old system, which is known and comfortable, rests underneath and is still accessible. Thinking about deploying technology in this way makes it possible for stu-

dents, teachers, schools, and districts to move ahead at different rates.

Learning 2.0 recognizes that students are the real workers in the education system and that school reform cannot proceed under the assumption that getting adults to work harder will make students smarter. Instead, we need to design and build learning experiences that are accessible directly by students and which better motivate them. When given clear standards and expectations, along with the expanding universe of educational options, students are capable of much more self-direction and monitoring than the current system expects or allows.

Understanding that student motivation is the key to achievement, Learning 2.0 takes advantage of the capacity for individualization that education technology offers. The official curriculum of most schools leaves large numbers of students either bored or bewildered. Both in the speed at which knowledge is presented and the style of learning experiences, the system needs more variety in type and style of education, not less. Individualization and specialization of learning will allow different mixtures of technical, artistic, and conventionally academic education to co-exist and prosper.

At the same time, Learning 2.0 offers the promise of greater integration between learning and application. The acquisition and storage model of learning forms the bones of schooling: learn, store, and recite on test. When the current education system was designed early in the 20th century, students left school early; some by the end of third grade, and nearly all by the end of high school. The world of work and adulthood greeted them, however harshly. But now the lag between acquisition and use can be long. High school graduation is no longer the gateway to economic self-sufficiency. The pathway to becoming a medical doctor, a lawyer, or a professor can take students well into their third decade before they practice what they prepared for.

Modern learning technology increases the capacity to mix acquisition and application. Through projects and apprenticeships, integrating experience and academic standards creates multiple pathways through school without the counter-productive effects of tracking, often changing students' aspirations. The capacity to do this comes partly from the Internet's network technology but mainly from changing how people think about learning.

The Learning 2.0 view of learning allows schools to integrate deeper learning into the conventional academic subjects. Learning to collaborate and to solve ill-defined problems are to the 21st century what industrial discipline was to the last 100 years, according to those who have studied what employers and society need.

Finally, Learning 2.0 holds the promise of substantial productivity gains. While the current practice of semester-long classes may endure for some time, the system needs to build the capacity for students to learn and be tested over different blocks of time. If there are productivity gains to be made in education, they will come about mainly through shrinking the number of years and months it takes a student to move through high school and higher education and by reducing the necessity for remediation for students who simply needed more time to master a topic.

Others have put forward similar ideas about education's future. The California Council on Science and Technology sees a 21st century learning environment of anywhere-anytime learning in which "teachers are working alongside instead of in front of their students" using an infrastructure built through public-private partnerships that grants access to both students and teachers.[5] The technology task force created by State Superintendent Tom Torlakson also calls for more individualization, collaboration, opportunities to learn outside of classrooms, and support for certification of learning through e-portfolios.[6]

Policy Opportunities

There is no shortage of opinion about policy options to best manage education technology in a new learning environment. Digital Learning Now!, has a list, as does the California Council on Science and Technology, the Pacific Research Institute, and *Education Week*. Each has informed the writing of this policy brief, but rather than a scoreboard or an exhaustive list, I provide a short list of policy opportunities that will have substantial leverage:

1. Invest in technological solutions to real and persistent problems in public schools.

2. Create an educational infrastructure for California's students, teachers, and schools.

3. Modify regulations to create better incentives and fewer barriers to using technology without losing the safeguards that regulation is intended to provide.

Invest in Solutions to Persistent Educational Problems

California should support technology applications where the benefits, challenges, and returns on investment can be readily and concretely shown. Consider four specific instructional areas: teaching English Language Learners, remediation, Special Education, and the transition from high school to higher education. Each of these heavily affects public education budgets and creates opportunity for developers and users alike, making each specific problem area worthy of an investment in tailored technology.

To understand the opportunity involved, one need only look at the structure of public education expenses. Rather than absolute increase, the important financial story in education is the shift in *how* money is spent. Much of spending growth has taken place *outside of the core function of classroom instruction*. In the Los Angeles Unified School District, from 1967 to 2005, the share of total spending directed toward regular classrooms decreased from 87 percent to 46 percent, while the share directed toward Special Education grew from 2 percent to 19 percent.[7] Statewide, inflation-corrected per pupil funding increased by 15 percent between 1980 and 2000, but the categorical program share of those dollars increased by 165 percent.[8] In 1980 there were 17 state categorical programs; by 2004-2005 the state accounting handbook listed 233 federal and state programs. We have attempted to solve education's problems by building around the educational core rather than by increasing its capacity.

English Language Learners

For example, English Language Learners make up nearly a quarter of California's students, more than 1.4 million pupils. If these students don't gain fluency by fifth grade they are likely to falter once they reach middle and high schools. According to a recent report, 90 percent are two or more years behind in math and English language arts and have gotten at least two Ds or Fs in the past year. By the time they are juniors in high school, three-quarters will be testing at the bottom—basic or far below basic—in math and English on state exams.[9]

Although estimates vary widely, some suggesting that an English learner adds more than 70 percent to the actual cost of instruction, all funding formulas acknowledge the burden. The Local Control Funding Formula that Governor Brown has proposed would add 35 percent to base funding for these students. Thus, a conservative estimate places the added cost of language learner instruction at more than $3 billion.[10] If technology could help students gain English fluency and exit ELL status only 10 percent faster than they do now, the state would save tens of millions of dollars a year. In addition, there would be great ongoing benefits for the students and savings for the state in reduced remediation costs.

Remedial Instruction

It is difficult to calculate the costs of remediation because so much of it is obscured in regular budgets. Every teacher engages in what educators inelegantly call "reteaching." But if one looks at only the numbers of students placed in middle and high school classes that are less advanced than the norm, those students so far behind that they are retaking courses in order to retain a chance at graduation, and high school graduates who are assigned to remedial classes in community colleges or state universities, the annual costs of remediation may reach $274 million, according to a Pacific Research Institute Study.[11] Another recent study put the cost at $3 billion for community colleges nationwide.[12]

The state has a compelling interest in getting remediation right. Already, remediation ranks high on the uses of education technology, but existing applications are often inadequate. The use of online learning for credit recovery has led to questionable practices in which a student who has failed a course enrolls in a different school or picks up a computerized learning packet and rapidly passes a test. While it is certainly the case that technology offers students the opportunity to catch up,

gaming the system and outright fraud threaten to discredit its use.[13,14,15]

Special Education

More than 680,000 California students are enrolled in Special Education, an inherently labor intensive and expensive form of individualized attention. The state's Special Education budget is more than $9.3 billion, some 17 percent of the general education budget covering about 10 percent of students.[16]

Although in its legal and technical sense, Special Education serves a protected category of students with specially credentialed teachers, it shares both techniques and problems that contemporary education designers are trying to address. Individualization is Special Education's forte. Its practitioners developed adaptive teaching techniques long ago, and they could teach the current generation of software developers a thing or two.

Paperwork, reporting, and due process requirements frequently sideline the pedagogical breakthroughs developed by special educators, however. Districts frequently use software to create the required Individual Education Plans, and more sophisticated software is on its way. Goalbook, a tiny startup that inhabits a few cubicles in the AOL building on Page Mill Road in Palo Alto, has applied the logic of social networks to the management of Special Education learning programs. In Goalbook, all the adults concerned with a particular student form a group. They share data. They communicate with one another so that a student's regular classroom teacher knows what the speech therapist encountered, and they all get the results of a diagnostic test administered by the district specialist. Online meetings replace at least some of the hard-to-schedule team meetings to create plans and track progress.

As the application is developed, teachers will be able to capture student work with their smartphones or tablet computer cameras and share it with the student's team. Teachers will be able to log the time they spend with students, thus creating an ongoing accountability trail that should obviate the need for many of the expensive and disruptive compliance reviews. The software also can work in other individualized education settings, including project-based learning and response to intervention. Daniel Yoo, who left the Special Education classroom to found Goalbook, estimates that the software could effectively add at least a week of instructional time a year for Special Education students, in essence building back the days that budget cuts have taken from the school year.[17]

College Readiness and Access

In addition to advancing English Language Learners, enhancing remediation, and making Special Education more efficient, an investment in technology can help light the pathway to college. The lack of articulation between high school and college is a well known problem illustrated in part by the numbers of students taking remedial work in college and the attendant costs. Currently well over half of the students entering the California State University system require remediation.[18] An even larger opportunity looms in finding ways to accelerate student progress through high school and college. Of the students who enter California community colleges with the intent of obtaining a degree, only 24 percent succeed in earning an associate degree or certificate, or in transferring to a four-year institution within six years.[19]

Most students in California are unaware that their pathway to college will be determined by a course placement test and not by their high school grades, their completion of an a-g curriculum, how well they perform on California Standards Tests, or their passage of the California High School Exit exam. The California State University System (CSU) requires most incoming students to take math and English placement tests. Each of the state's community colleges is allowed to create its own placement tests. In the community colleges, over 83 percent of students are placed in remedial math courses and 72 percent in remedial English. In effect, these students have been admitted to college but are not actually going to college. They go to campus, pay tuition, and forego earnings from paid employment, but passing remedial courses does not earn them graduation credit.

Existing efforts to address the problem have thus far not had large effects on remediation rates. But experience with the Early Assessment Program (EAP), which adds questions to the standardized tests students already take, illus-

trates how information technology can help. The EAP was initiated by CSU in collaboration with the California State Board of Education and the California Department of Education as a way of providing rising high school seniors with an indicator of their college readiness.[20] In addition, the CSU will waive placement tests for students who score well on the EAP, and at least 49 community colleges have agreed to substitute EAP results for their placement tests.

For the most part, however, the EAP has failed to get actionable and salient information to students, teachers, and parents so that students know how to and are motivated to better prepare themselves for college. EAP test results are sent to students on their state STAR test report, along with much other assessment data. Other than reference to a website (http://www.calstate.edu/eap/), no substantive information is included in the report. A focus group of Los Angeles students found that most were not familiar with the test and had no idea what to do with the information it provided.[21]

Additionally, students typically do not receive results until they are registered for their senior year classes, too late to alter their schedules to take tutorial or remedial work, even if their high school offered it, which many don't. The CSU offers online courses in expository writing, but a student has no way to access these directly. Likewise, the university system offers professional development for high school teachers, and there is evidence that it is effective, but given cutbacks, most school districts don't have spare professional development time to send their teachers to classes and workshops.

Summary

If California viewed English Language Learner programs, Special Education, remediation, and the transition to college as the "low-hanging fruit" that digital policy might address immediately, then it would become possible to have a discussion about the size of the investment needed and the returns that might be generated. Just looking at the problem areas introduced above, one can see the possibility for huge savings that could be invested in increased system capacity. Some of this savings would remit to public budgets, in the form of reduced remediation costs, for example. Some of it would be found in increased capacity, the ability of the system to educate more students within existing constraints. If technology policy did nothing else, targeting these four areas offers potentially huge returns. However, the addition of a little systems thinking raises the possibility of a fundamentally different learning system, one in which California could lead the nation.

Create a Learning Infrastructure

California needs to invest in a learning infrastructure for students that uses modern network production technology. By thinking of the student as the end user rather than designing educational products that will be attractive to a textbook adoption committee, the state can open up learning to new participants, approaches, and ideas.

Rather than designing a single statewide virtual school, the concept of Learning 2.0 invites us to think in terms of a collection of networked resources that adapt with use, continually improving and redesigning. Rather than a virtual "one best system" school, Learning 2.0 invites us to adopt one of the design principles of flexible specialization in manufacturing: breaking down complex processes into modules, lessons or projects. These can be combined in different ways to create customized products without starting from scratch with each one. Think of the children's toy Legos.

The first design principle of Learning 2.0 is to get data and learning tools in the hands of students under the (sometimes) watchful eyes of their parents.

Second, build an open source system based on the experience of the users, one that is expandable, fixable, and tweakable. Think Linux, the free open-source operating system, or Moodle, the open-source classroom and lesson system, rather than relying always on corporate and proprietary sources. While for-profit venture capital and product development is necessary, it is important that public policy prevent corporate capture.

Third, build systems plural, modular not monolithic, scalable not singular.

Fourth, experiment! Avoiding a rush to judgment is difficult for policy makers, but in the case of online educational content, it is absolutely necessary. Instead of a standard design, California needs many laboratories. Learning

2.0 is still in the experimental stage. All the examples are small, still in the D(evelopment) phase of R&D. It is far too early to impose a standard design or to mandate a single system. We need trial and error. We need to learn from experience, and its inevitable failures.

Given these design principles, the success of Learning 2.0 necessarily relies on three sub systems: information, learning experiences, and assessment.

Access and Information

Think of access and information as lights on the pathway to college and career. Currently, the pathway is not well lit, and it's not level, either. Professional class families can illuminate the way to college for their children through the lived experience of parents. For poor and working class families, though, there are hidden rocks and potholes. By when should a child be redesignated as English fluent to have a good chance of getting into college? Why are class placement tests at a community college important?

At a minimum, students and their parents ought to have online access to reliable information about where they are on the pathway, an educational GPS function. They shouldn't have to go to school to ask, find a piece of paper that was mailed from the state, or try to interpret the meaning of archaic numbers or percentages. They should know what testing hurdles they face and how to prepare for them. They should know the options that are available in different schools, such as tutoring and support.

A 'Bring Your Own Device Policy'

Creating access to devices and bandwidth is not sufficient to bring about a new learning system. As teacher and frequent technology commentator Aran Levasseur writes, "We can't just buy iPads (or any device), add water, and hope that strategy will usher schools to the leading edge of 21st century education."[22] Access to technology alone will not solve public education's problems or invent a new learning system, but assured access is a necessary first step.

Thus, the slogan of "No Child Left Offline" has entered the policy conversation, and State Superintendent Tom Torlakson's technology task force recommends assuring that every student has a digital learning device that can be connected to the Internet: 1 to 1 computing with any time, any place, any pace connections.[23]

Achieving the goal of 1 to 1 computing is best accomplished by placing agency in the hands of students through what is called a Bring Your Own Device (BYOD) policy. Increasingly, bringing one's own device also entails bringing one's own mobile network connection. Student access to mobile devices grows rapidly. According to a Project Tomorrow survey, 80 percent of students in grades 9-12, 65 percent of students in grades 6-8 and 45 percent in grades 3-5 are smartphone users.[24]

To support BYOD, the state should use its considerable purchasing power and regulatory powers to forge constructive partnerships with manufacturers and vendors. For example, it could negotiate substantial discounts on devices—computers, tablets, and smartphones—and connection contracts. It could then issue technology vouchers to students, their families and their teachers redeemable through the participating partners.

In order to form successful partnerships, the state will need to bring together interests and advocates both from within government and outside, groups and people who do not work together often. These include the California Department of Education, the California Public Utilities Commission, the Federal Communications Commission, the California university and college systems, and various advocacy organizations. Part of the reason for a cross-agency and multiple interest approach rests in the necessity to form a political coalition, and part rests in the need to address existing constraints. For example, there is considerable anxiety among school district personnel about how the BYOD can be implemented within the requirements of the *Eliezer Williams, et al., vs. State of California, et al.* settlement and existing state regulations.[25] Successful implementation of any BYOD plan will require simplicity of purchase: a transaction much more like that at Amazon and much less like a typical state or school district process.[26]

Collaboration among these interests will be required to finance universal student access. The California Education Technology Fund already exists and could be enlarged through small

surcharges on telephone, cable, and satellite services. Other states are already devising creative state-funded programs that are similar to the federal E-rate program. In addition, as the Torlakson task force notes, "California has an opportunity to leverage the education lottery funds to sustain educational technologies that will be necessary to support 21st century assessments. The state generates approximately $1 billion in lottery funds with a projected increase of 40 percent for 2012-13."[27]

A plan for universal access and quality content should make California a strong contender for federal support.

Increasing School Access To Networks

In addition to direct student access through mobile devices and at home, the state needs to improve access at school. Through CalREN (California Research and Education Network) California has constructed a high-speed network, including a fiber optic backbone and associated nodes serving 81 percent of California's schools, 87 percent of school districts and all 58 county offices. Nevertheless, California is still behind other states in connectivity, and schools serving about 20 percent of the students in the state are not connected. According to the Corporation for Education Networking Initiatives in California, which operates CalREN, the need is particularly great in the Central Valley.[28] Also, there are still many towns and rural areas without any reliable broadband Internet service at all. An analysis undertaken by the California Public Utilities Commission shows broad swaths of the state without DSL-speed service. The lack is detrimental not only to education, but also to health care delivery, and clearly to the local economies: Locations with broadband services attract growing enterprises and more highly paid jobs.

There are substantial recent government incentives to extend broadband services. The 2009 American Recovery and Reinvestment Act ("the stimulus") provided $7.2 billion for broadband investment and a national broadband plan. And a 2010 report by the Public Policy Institute of California tracks several hundreds of millions in state efforts.[29]

Legislation and contracting also need to enable schools and districts to access the rapidly emerging world of cloud computing. The need for, and the viability of, district-run data centers may soon be eclipsed.

Building a Useful and Fair Data System

Educators frequently observe that a great deal of information is available in schools, but teachers and students seldom use it. To make necessary information useful, it has to be packaged and presented in timely and understandable forms. Now, as Frank Catalano writes, data are trapped in incompatible systems, "the educational equivalent of Hotel California: data can check in any time it likes, but it can never leave. Or be effectively used by teachers."[30]

Most data policy discussions concentrate on large aggregations: big statewide systems or data standards that allow comparisons across the country. California's data system, CALPADS, is beginning to produce reports after a long and troubled development, but it is limited in scope and utility. It is designed largely as a better monitoring and accountability mechanism, tracking dropouts, course enrollments, and program participation. But direct and real time feedback to teachers, students, and parents is not part of its design capacity.

The Michael and Susan Dell Foundation is attempting to marry an interest in data standards (and there are many competing ones) with systems and software that make information directly available to students and teachers. "I want teachers saying that they want this stuff," says Lori Fey, director of policy initiatives for the foundation. The Texas student data system illustrates such a system, operating statewide, yet locally adaptable.[31]

California is still years away from the sophistication of the Texas system. In the short and medium term, therefore, policy needs to support schools and districts that are developing useful systems, seeking solutions to both the technical problems involved and the human ones.

Several districts, including Riverside Unified, have created dashboards that provide critical information to students. The Riverside dashboard, for example, presents five indicators. A student and his or her parents can

know whether assignments are missing or classes skipped. The California High School Exit Exam and credits earned toward graduation show up in other gauges.

Dashboards exemplify one path toward making data useful to teachers and students. Another is to increase the diagnostic and clinical capacity of data systems, by making them work at the student and classroom level. Practices such as data teams and clinical coaching have been used for decades. New evaluation systems that balance formative feedback with summative performance assessment help illustrate how data can be used, and they develop support for data use. To be successful, any data system must direct a substantial portion of its resources to on-the-ground professional development and to rearranging the teacher workday so that collaboration and working with data become routine.

Emphasizing data system development at the school and district level addresses the fact that big statewide data solutions are often at odds with the lived experience of teachers and students, who view state-issued student achievement reports as tardy, irrelevant to their teaching, and personally threatening. Clearly, if we want teachers to support data systems, the systems must seem fair and useful.

Still, the promise of rapid data feedback for teachers and students is clear. As Salman Khan writes, "When teachers have real-time data and a clear understanding of every child's needs, they can use their precious classroom time more effectively and flexibly. When students are learning at a pace and level appropriate to their individual needs, they are less likely to disengage or act up."[32]

Learning

The number of iPhone and iPad apps, many free, grows almost hourly. Interesting ones appear frequently. It's possible to dissect a rat electronically with nearly the same precision as a knife, and without the formaldehyde smell or the ultimate sacrifice on the part of the rat.

In fact, there is so much learning material on the Internet that it is difficult to sort through and evaluate it all. There are great lectures and not-so-good ones. There are wonderful applications and cranky ones that don't work or are overpriced. Learning 2.0 would require a system for "curating" online content, as several existing organizations have begun to do. It would also allow user or expert ratings of learning programs.

We already have a free market in educational applications with sales directed at students and their families. If we are to make good use of it, we need to safeguard the public interest with both consumer and expert reviews and a ranking system. If TripAdvisor can warn travelers about bed bugs and travel industry nonsense, we should warn students and teachers about software bugs and pedagogical nonsense.

Learning 2.0 would highlight California standards and eventually those of the Common Core, as if standards were scout merit badges and the learning applications were ways to achieve them. This can help students to figure out what they need to know, how to get there, and how one skill or concept is connected to others. Even young students—using material from Leapfrog, for example—can obtain an accurate assessment of what they need to do and self-direct.

Learning 2.0 can assist the development of particularly sophisticated applications, such as social or scientific simulations. Such material is being developed by universities, foundations, and advocates for particular learning modalities. For example, http://pbl-online.org/ provides fully developed examples of project based learning, as does Connect Ed for projects and Linked Learning (http://www.connectedcalifornia.org/).

By using Internet-enabled collaboration, the capacity for creating lessons, experiments, and projects passes to teachers and arguably to students. While many, maybe most, teachers won't invest the time to wade through the massive library of lessons and resources available on the Internet, increasing numbers of teachers are doing just that. Organizations such as Gooru are curating and organizing online material and creating a community of contributors.[33] Wikipedia projects in education are multiplying, the product of individual and cooperative initiative, largely unstructured by states or schools.[34] Minnesota teachers (and others in many locations)

are writing their own textbooks or radically supplementing the text.[35] The Flat Classroom Project, begun by two teachers—one in Los Angeles, the other in China—joins students and teachers from around the world, both virtually and in person.[36] Curriki, begun by former Sun Microsystems chairman Scott McNealy, claims more than 5.4 million users for its lesson and curriculum sharing site.[37] Each of these examples illustrates a potential change in the division of labor, one in which teachers become the producers of educational material as well as its consumers.

Gaining Credit

For a century, the two most important qualifications for passing a course have been the date of manufacture of the student and the number of hours the student's bottom has been in a classroom chair. Access to learning was largely a function of birth date, and credit for a course was a function of class attendance and participation. Students took lots of tests generated outside the classroom, but with the exception of the SAT, which is a gateway to college, few of the tests provided substantive rewards for students.

Learning 2.0 can change that. Students could take tests when they were ready, could pass courses when they were ready, could take tests as formative feedback.

Unbundling teaching and testing also allows the whole education system to become more productive. If the financial rewards for school systems were correctly managed, it might also incentivize schools and districts to accelerate learning. And instead of drawing students away from substantive learning, a new generation of tests would motivate students and place the teacher in the position of a supportive tutor and coach to help them reach their goals.

Policies to Create Learning 2.0

To bring Learning 2.0 into being, the state needs to craft the right policy instruments. Most governmental levers commonly used in education won't work. Mandates are almost useless. A new state agency isn't necessary. A contract for work and a deliverable can't be specified.

A government, quasi-government corporation, or a public interest nonprofit corporation is closer to the mark. The College Board, which was created in 1900 to expand access to higher education, may serve as an organizational model. So, too, might the Tennessee Valley Authority, which Franklin Roosevelt created as a federal corporation with the "flexibility and initiative of a private enterprise."[38] Scotland, which created the first national education intranet system, used a quasi-governmental organization, Learning and Teaching Scotland, now merged into Education Scotland. There are many existing organizations in California that might coalesce to bring Learning 2.0 into being.

Functionally, a Learning 2.0 network should draw together scholars in key disciplines including cognitive science, pedagogy, testing and assessment, and organizational development and behavior. It should add developers and teachers, not as representatives of firms or organizations but as independent experts.

Second, it ought to adopt a clinical trials format that would allow school districts and teachers to evaluate their experiences with educational software. This should be simple, unobtrusive and offered as a plug-in to any pedagogical system to allow self-evaluation and reporting. Using newly developed educational software should not only make students smarter, it should make the system smarter.

Third, the network would need the capacity to help with the heavy lifting: writing or brokering the analytical engines that make software powerful. The difficulty is that there is substantial incentive to monetize development. That's what venture capital in research and development does. If the policy goal is to enlist teachers, students, and scholars who know more about pedagogy than computer code, then the underlying engines need to be free or easily available. They should be part of the tool kits of educators, just as statistical packages are for academic researchers.

Fourth, it ought to host and broker relationships between users and vendors. While there is a thirst for high quality software, there is also a lack of understanding about what real teachers do and the conditions under which they work that renders too much existing software clunky or less than opti-

mal. Typically, teachers are involved only in pilot testing at the end of the software design process. Their input should begin with idea development and continue through prototyping, a process that can take advantage of the capacities of social networking.

Regulation

Much policy advocacy concerning educational technology concentrates on deregulation, essentially blaming the failure to advance on regulatory overburden and self-protection by existing educational interests. Certainly, no one has much good to say about California's regulation of emerging forms of learning. On the scoring system created by Digital Learning Now!, the advocacy organization headed by former governors Jeb Bush and Bob Wise, California ranks last among the states.[39] County superintendents examined policies governing online and blended learning, and declared them the most complex in the nation, adding "California has apparently decided that it must lead in this area, creating the most complicated, confusing, and impenetrable set of policies in the state."[40]

That said, much of the case that is made for deregulation is ideological, ignoring the fact that the original purpose of regulation was student protection, and assuming that new modes of teaching are necessarily superior. Rather than wholesale deregulation, therefore, we need an easing of rules that encourages experimentation and integration of technology in existing school districts. Technology travels a path from the edges to the center, from remedial and ancillary instruction to the official curriculum in core courses. Consider the following policy changes as ways to bring the center into play.

'Seat Time' or 'Merit Badges'

No structure of American education is more deeply embedded than that which requires student attendance and pays school districts on the basis of how many days, hours, and minutes students spend in school. And no structure is more limiting to the overall productivity of public education.

Part of the promise of Internet-based learning technologies is to loosen the link between time and achievement, allowing students to achieve at their own pace and, when possible, accelerate their learning. Much as a Boy or Girl Scout achieves a merit badge for demonstrating knowledge or skill, a student could receive a "badge" for meeting a standard. Students would get credit for performances when they were ready, rather than waiting for others or rushing to completion. This alternative has merged with the growing accountability mentality on the part of public officials to pay for results rather than attendance. Some 36 states have adopted policies that allow school districts to provide credits based on proficiency rather than seat time.[41] New Hampshire rquires that all credit attainment be on the basis of mastery, and the Florida Virtual Academy is paid by the state only when its students achieve mastery.

The problems of wholesale departure from attendance-based finance are thorny ones: what happens to a school district's duty to provide safe custody and care of students. Should districts be penalized financially when high achieving students finish in fewer than four years? What's to prevent the improprieties found in the for-profit vocational schools from spilling into virtual education? Prudence suggests that the chains that tie attendance to achievement and financial flows to schools should be loosened carefully, and gradually.

The 'Contiguous County Rule'

Under the California Education Code, online or virtual education can only be provided to students within the home county or surrounding counties of the school district, charter school, or county office offering a course of study. Thus, an online course offered by the Kern County Department of Education could be offered to students in Santa Barbara, Ventura, Los Angeles, and San Bernardino counties, but not to those in Riverside or Orange counties.

The California Virtual Academy(ies), a chain of charter schools that use the proprietary K12 curriculum, works around this restriction by anchoring its programs in nine counties throughout the state, thus allowing it access to most of the state's students. If one of the goals of a statewide network is to greatly expand access and choice for individual students, however, then direct statewide access is necessary so that students can stay enrolled in their home districts or charter schools and access the best online instruction available anywhere. And if one of

the goals of a statewide network is to provide incentives to existing public school districts and public-private partnerships, then the same statewide principle would apply.[42]

The California Diploma

Advocated by the authors of the Online K-12 Education, College Preparatory Courses Initiative (also known as the California Student Bill of Rights Initiative, which was proposed in 2012 but did not qualify for the ballot), the California Diploma would authorize the California Department of Education to issue a diploma to any student who had successfully completed coursework that would qualify for admission to the University of California and the California State University system.[43] The California Diploma would allow students to graduate by taking high quality, college-qualifying online courses not offered through the school district where they were registered.

The Diploma would provide students with options for graduation without requiring them to leave their local schools. At the same time, it would provide an incentive to schools and districts to respond to student demand for particular courses or modes of delivery. It would expand blended learning options for students.

A Chance to Lead the World

The policy framework proposed here will not solve all of the problems in California's public school system, or even address all of the challenges to be faced in adopting Internet-based technology. But policy changes like these would begin to move California out of the eddies of early 20th century school design. While there is no reason to adopt technology for its own sake, it is both visionary and eminently practical to connect the state that is at the headwaters of the digital revolution to the task of building a learning system for the current century. Much of the school reform debate in California has focused on how the state can catch up with other states and countries. The policies outlined in this brief would give California a chance to lead the way toward a new and more effective learning system.

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We would like to thank the California Education Policy Fund (a sponsored project of Rockefeller Philanthropy Advisors), the Dirk and Charlene Kabcenell Foundation, and the Stuart Foundation for financial support for the publication of this policy brief. The views expressed are those of the author, and do not necessarily reflect the views of PACE or its funders.

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