SAN JOSÉ STATE UNIVERSITY

# REINVENTING PUBLIC HIGHER EDUCATION

## A Call to Action

Office of the President

**Public higher education is in crisis.** In California and throughout the United States, the rising cost of delivering education and the decrease in public funding for education has placed a heavy burden on students and their families. As a result, the opportunity for affordable higher education is becoming available to fewer people. Educational institutions urgently need new approaches to teaching and assessing learning that are personalized, collaborative, engaging and that relate to real-world, 21st-century problems. The good news is that we have powerful tools to address the challenges we face.

## What are the challenges?

- **While the cost of education is increasing, state support for public education has been rapidly shrinking.**
- **The nation loses an estimated $30 billion annually due to inefficient credit transfer systems. Students and educational institutions waste time and money moving students toward graduation.**
- **Barriers to retention and graduation of students in science, technology, engineering and math (STEM) hinder the country's future economic prosperity.**
- **Advances in technology, the expansion of online learning and the needs and expectations of tech-savvy students are changing the role of colleges and universities.**

The approaches to teaching and learning proposed in this white paper are an expansion of the concepts presented in our 2011 white paper titled "The Open Learning Ecosystem: Transforming Education through the Virtual STEM University." [1]

## Is the financial model for public higher education broken?

In a 1996 interview, esteemed scholar and futurist of the 20th century Peter F. Drucker made the following comment about the outlook of higher education: "30 years from now the big university campuses will be relics … Do you realize that the cost of higher education has risen as fast as the cost of health care? And for the middle-class family, college education for their children is as much of a necessity as medical care—without it the kids have no future." [2] In Drucker's view, the uncontrollable and ever-increasing cost of higher education, void of any added value in content or quality, cannot be sustained and will soon reach an untenable situation. As 2012 is roughly the mid-point of Drucker's 30-year prediction, it behooves us to examine Drucker's assertion.

**Collective pending student loans is currently more than $1 trillion, which surpasses the nation's credit card debt.**

[1] Qayoumi and Polese, "The Open Learning Ecosystem: Transforming Education Through Virtual STEM University," June 2011. Feedback on the paper was positive and was picked up by CISCO's Twitter page. Consequently, CISCO posted a four-part interview with us on this topic that can be accessed as background information.

[2] Lenzner, R., & Johnson, S. S., "Seeing Things as They Really Are," *Forbes*, 159(5), 122-128.

[3] "The Condition of Education," www.nces.ed.gov/programs/coe/tables/table-gsn-1.aAccording to the National Center for Education Statistics, from 1986-87 to 1996-97 the cost of attending public universities rose by 20 percent, while for private universities the increase was 31 percent after adjusting for inflation. Roughly a decade later, in absolute dollars by 2010, the cost of attending public universities jumped to more than $12,000 and $35,000 for private universities. From 1996 until 2011, the inflation adjusted percentage increase for attending college jumped 100 percent for public institutions and 50 percent for private institutions.

[4] Hellenbrand, Harry, "This is not Country for the Young," 2011, CSUN, 1. According to the 2008 biennial report of the National Center for Public Policy and Higher Education, between 1982 and 2007, college tuition and fees rose by 439 percent, while

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>
> —Peter F. Drucker

Research from the National Center for Education Statistics[3] and the National Center for Public Policy and Higher Education[4] shows the alarming trend of dramatically diminished state support for public higher education—while the cost of delivering and getting an education has increased.

To illustrate this trend, the February 2012 issue of *Postsecondary Education Opportunity*, a public policy analysis of opportunity for postsecondary education, published a report titled "The Race to Zero."[5] The report has plotted the state financial support for operating expenses of higher education institutions against personal income per thousand dollars from 1961 to 2012 for every state in the union.

To emphasize the seriousness of the erosion in state support since 1960, the report extrapolated the trend between 1980 and 2012 to calculate the year in which each state's fiscal support will hit zero. Based on this study, if this trend continues Colorado will be the first to hit zero in another 10 years, followed by Alaska in 2027. But more than a dozen other states will follow the same trend by 2050. California will reach zero by 2052. By 2100, state support for higher education will eventually zero out in 24 additional states, leaving roughly 10 states with continued support. In other words—to our dismay—funding trends for higher education today look like an EKG reading of a person headed for a heart attack.

The funding shortfall has forced many public universities to reduce enrollment at this very inopportune time. As we'll illustrate later, the nation needs more college graduates, especially in the science, technology, engineering and math (STEM) fields. The significant drop in state support for higher education has also prompted a necessary and concomitant sharp increase in tuition and fees for public universities. Although tuition at public institutions is considerably lower than at private universities, the rise in tuition rates at both public and private institutions is producing hefty increases in the amount of student loans. In fact, collective pending student loans is currently more than $1 trillion, which surpasses the nation's credit card debt. Presently, student loans exceed $6 billion annually.[6] As the cost of attending college increases further, the doors of opportunity will be shut to an ever-increasing segment of our population, especially in underserved communities.[7]

general income only rose by 147 percent. In the 1960s, education, health and welfare, and pensions accounted for 18 percent of the total U.S. budget, while today it hovers around 48 percent. The share of education has remained relatively constant, meaning that the escalating cost of health and welfare and pensions has resulted in shifting our priority from intergenerational transfer of knowledge to primarily intra-generational transfer to the aforementioned areas.

[5] "The Race to Zero," *Postsecondary Education Opportunity*, February 2012. www.postsecondary.org/commondetail.asp?id=1625

[6] "Student Debt Exceeds One Trillion Dollars," NPR, April 24, 2012. www.npr.org/2012/04/24/151305380/student-loan-debt-exceeds-one-trillion-dollars

[7] Those who do graduate from college may carry such a heavy loan burden that they might not be able to afford participating in public or community service. This will also hinder the development of healthy, sustainable, long-term economic structures and a strong workforce supply that are needed as we continue to evolve into a technology-based society that requires greater numbers of STEM graduates.

## Inefficient credit transfer systems cost billions

In addition to rising educational costs, the transfer of credits from one college or university to another is a challenge for most students because an overwhelmingly large number of students attend more than one institution. Due to the cottage industry nature of higher education, every institution believes its set of courses—even introductory, lower-division courses—must be unique. Although a few university systems have successfully adopted common course numbering to facilitate credit transfers, these systems are the exceptions.

This inefficiency causes most students to lose some of their credits during the process. Part of this loss can easily be attributed to students receiving insufficient academic advising. Students may take courses at community colleges that will not transfer to four-year institutions because the courses are part of vocational/technical programs. On average, students in California who attend a community college and transfer to a four-year college complete 154 semester credits, while only 120 are needed for most majors. They end up accumulating one year of additional schooling prior to attaining a bachelor's degree, which is clearly a waste of valuable time and money. In fact, the nation loses an estimated $30 billion annually due to poor and inefficient transfer systems.

## Economic vibrancy and education

During the past century, science and technology have propelled our economy. After World War II—especially in the post-Sputnik era—the rapid growth and expansion of research and development in various STEM-related fields helped our economy thrive and significantly enhanced the country's quality of life. Unfortunately, the STEM competency of students in the U.S. is still one of the lowest among all developed nations. While less than 16 percent of four-year college degrees in the U.S. are in STEM fields, in Korea it is 38 percent, in France 47 percent, in China 50 percent and in Singapore 67 percent.[8]

Over the next 10 years, five out of eight new jobs and eight out of 10 of the highest paying positions in the U.S. will be in STEM-related careers. Although California has 11 percent of all U.S. jobs, it has 15 to 18 percent of STEM-related jobs nationally.[9] Thus, many experts advocate a deeper and more effective integration of STEM as part of a liberal education. That is, the acquisition of STEM competency must be fully integrated with arts, humanities and social sciences. Unfortunately, our educational system, sometimes with the best of intentions, has kept arts and humanities and mathematics, science and engineering in discipline silos.

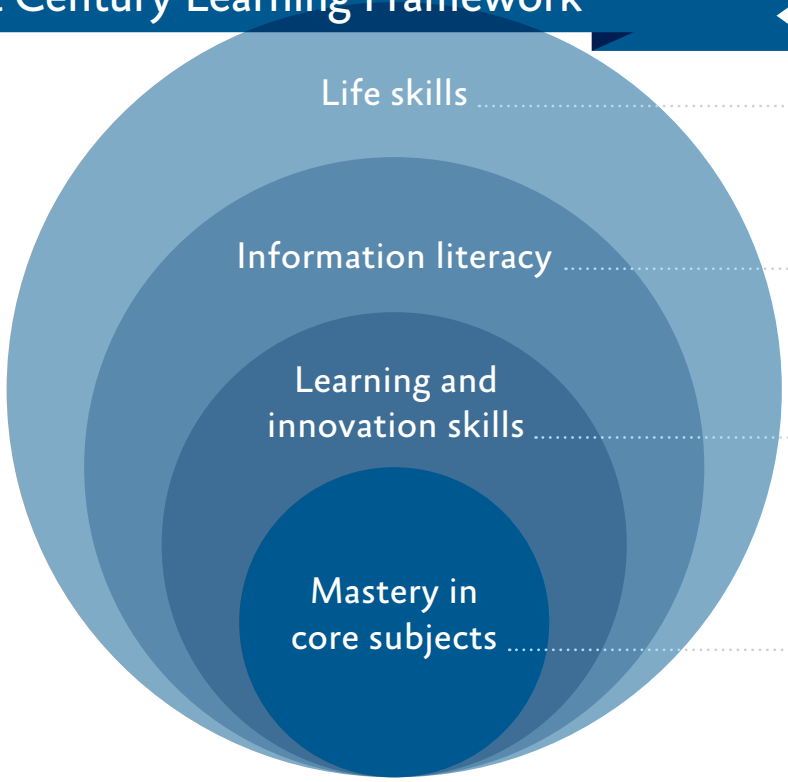
[8] National Research Council, "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future," 2007, Washington, DC: The National Academies Press, 16. www.nap.edu/catalog/11463.html

[9] Oftsein, J, and Shulock, N, "Technical Difficulties: Meeting California's Workforce Needs in Science, Technology, Engineering, and Math (STEM) Fields," 2009, 2. www.csus.edu/ihelp/PDFs/R_STEM_06-09.pdf

[10] Griffiths, Phillip A., & Cahill, Michele, "The Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy," 6 – 7. www.opportunityequation.org/uploads/files/oe_report.pdf

[11] Partnership for 21st Century Learning. www.p21.org/overview/skillsframework

# The 21st Century Learning Framework




Flexibility and adaptability, initiative and self direction, social and cross–cultural skills, productivity and accountability, leadership and responsibility.

Media and technology skills.

Creativity, critical thinking, problem solving, quantitative reasoning, communication and collaboration.

English, languages, arts, mathematics, economics, science, geography, history, government, and civics.

The Carnegie Foundation eloquently stated: "Mathematics and science are essential components of a liberal education, the backbone of logic and analytic thinking from early childhood through the most advanced levels of learning across the academic disciplines. Science, technology, engineering and mathematics enable us to understand the natural world, the built environment, systems of society and the interactions among them that will determine the future of our planet."[10] Similarly, art enables us to expand our perspective and empowers us to seek change through our imagination. Knowledge of humanities and social sciences sharpens ones judgment and builds the capacity to innovate and manage ambiguity.

## STEM competency comparison

| | |
|---|---|
| California | 16% |
| China | 50% |
| France | 47% |
| Korea | 38% |
| Singapore | 67% |

At a time when the U.S. needs more college graduates with a solid liberal education that includes STEM proficiency, college degree attainment is becoming more difficult. In the U.S., only 50 percent of those entering college in public institutions attain a bachelor's degree in six years. And, as we've mentioned, less than 16 percent of these degrees are in STEM-related disciplines. According to the April 2012 President's Council of Advisors on Science and Technology (PCAST) report, the U.S. produces approximately 300,000 graduates with bachelor's and associate's degrees in STEM fields every year. If the number of STEM graduates remains the same, in a decade the U.S. will face a shortage of one million STEM majors.

There are a number of obvious strategies to address this shortfall, namely enhancing the STEM preparation of high school students so a larger percentage of these students will not only be college-bound but also college- and STEM-ready. However, PCAST identified another important approach: addressing the retention and graduation of college students in these fields. According to PCAST, fewer than 40 percent of students who enter college with an intention of majoring in STEM actually graduate with a STEM degree. If we can increase the existing 40 percent retention to 50 percent, we can achieve 75 percent of the goal of achieving one million more STEM graduates by the end of this decade.[12]

## Barriers to retention of STEM majors

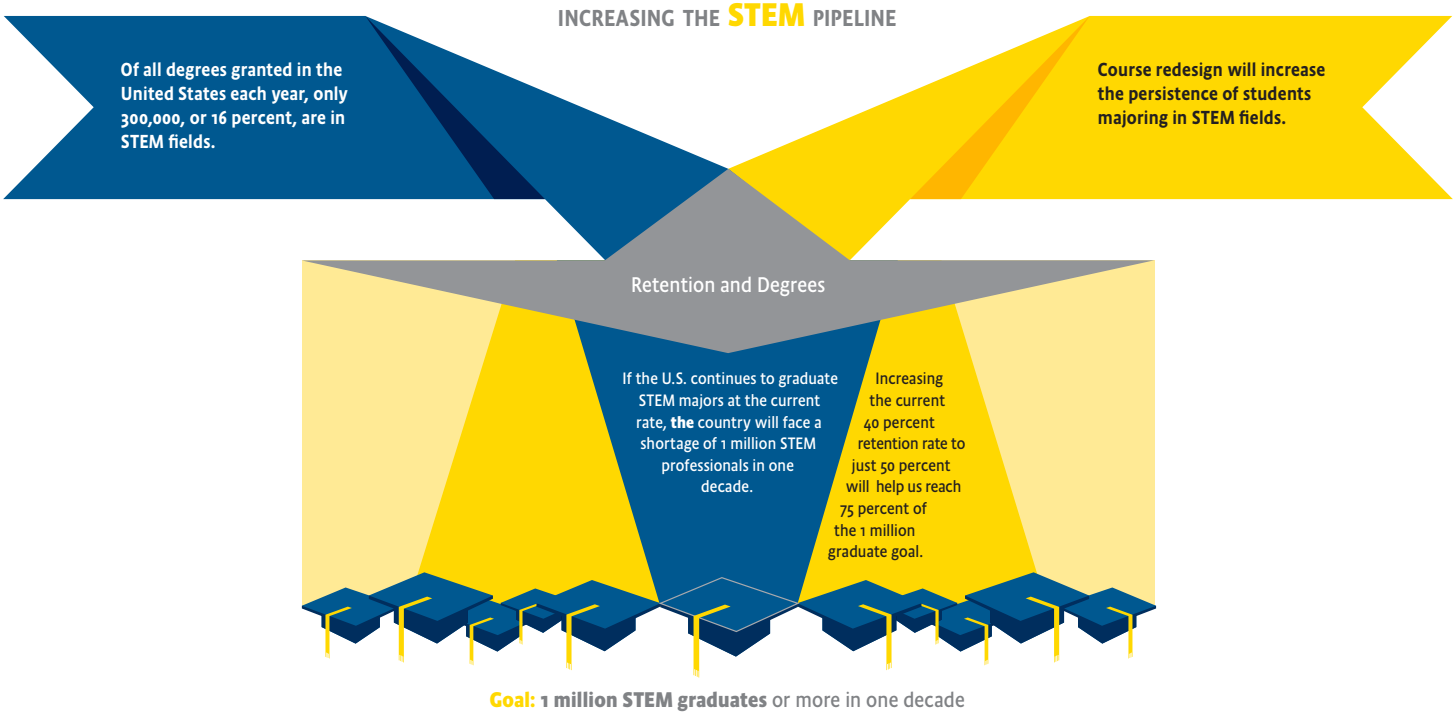
1. Traditional lecture-style teaching methods: Active learning, by contrast engages students in a series of activities such as simulations, labs, group presentations, discussion groups, debates, role-playing, reviewing case studies, etc. Studies have shown the benefits of diversification of teaching methods.[13]

2. Current curriculum design: During the first two years, students must memorize a large amount of basic facts and theoretical material with limited exposure to the application or integration of concepts. Without providing an overarching, meaningful context or application of a multitude of facts, students often become overwhelmed, lose interest and drop out of STEM fields.

3. Inefficient credit transfer systems: Improving inefficiencies will save the country billions of dollars and increase the throughput—including more STEM graduates.

[12] President's Council of Advisors on Science and Technology, "Report to the President. Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering and Mathematics." www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-executive-report-final_2-13-12.pdf

[13] Felder, R. M., G.N. Felder, and E.J. Dietz, "A longitudinal study of engineering student performance and retention v. comparisons with traditionally taught students," Journal of Engineering Education, 1998, 87(4), 469-480.




## The need for innovation and transformative change

Many economists believe that the 19th century was powered by coal and raw materials, the 20th century was powered by manufacturing and industrial process and the 21st century will be powered by human innovation. While there are many definitions for innovation, we will use: "creativity in the service of humankind." Given the enormity of higher education's challenges, the key for survival is innovating our way out of the current quagmire.

In order to encourage innovation in higher education, we need to create an environment where innovation can thrive. Traditionally, higher education has stuck to the status quo. The academic training and hiring models of the 20th century promoted hyper-specialization and reduced possibilities for flexibility and change in the curriculum. While 19th century institutions hired generalists who could be redeployed to areas of need, 20th century institutions hired subfield specialists, which resulted in departmental structures that became increasingly fossilized and discipline-specific. To effectively enhance the level of innovation, promoting flexibility and risk-taking must become commonplace in higher education.

There is little dispute that Silicon Valley has led the world in innovation. It is incumbent upon us to learn from the unique characteristics of this epicenter of innovation. We must seek new ideas and approaches from other industry sectors[14] and promote audacious thinking through carefully reviewing and adapting effective innovations in administration, teaching and learning, especially in STEM education. For instance, imagine the possibilities if we adapt VISA's financial transactional model[15] to implement a common course numbering system to facilitate course transfers across all higher education institutions.

Using a more innovative model lets us also examine the cost of higher education. Unlike most other industries, education has not taken advantage of technology to reduce costs. With the cost control framework of the past several decades, most higher education institutions have primarily concentrated their efforts on reducing the cost of administrative processes via automation and process redesign, etc. These efforts have no major cost reduction in the total since, for most colleges and universities, the non-academic costs[16] range from 20 to 25 percent. This means that if these expenses are cut by a quarter the total impact is roughly around five percent. Commonly, attempts at cost controls in the academic area have been vociferously rejected or viewed with serious suspicion.[17]

How can we reorganize institutions to facilitate the necessary transformation for higher education? Much of what we now believe is academic tradition is actually fairly recent in origin, but universities tend to cloak their own transformations in order to present the illusion of changelessness. Since universities traditionally value processes and guarding the status quo, higher education leaders must be ambidextrous. These leaders must work toward a balance between the covenants of tradition and transformation, while moving their respective institutions and industry to new heights.

[14] Jaruzelski, Barry, Ioehr, John, and Holman, Richard, "The Global Innovation 1,000: Why Culture is Key?" Strategy & Business, Winter 2011, 65. www.booz.com/media/uploads/BoozCo-Global-Innovation-1000-2011-Culture-Key.pdf. In 2011, as part of its annual study of the top 1,000 global innovation companies, Booze and Company did a focus study of Silicon Valley companies to see if there are unique characteristics in the culture of these enterprises that set them apart from other innovation companies located elsewhere. First, the study demonstrated that 257 of these innovation companies reside in the San Francisco Bay Area. But, more importantly, they found that Silicon Valley companies are three times as likely to say that their innovation strategies are tightly aligned with enterprise business strategies. More specifically, 54 percent of Silicon Valley versus 14 percent of all 1,000 companies demonstrated this characteristic. Second, in 46 percent of Silicon Valley companies the corporate culture supported innovation strategies. By contrast, it was only 19 percent for the other companies in the list. These findings clearly demonstrate the breadth and depth of the change needed in higher education.

[15] The financial industry has successfully been using an efficient global transfer system for decades. According to Dee Hauck, the former CEO of VISA, more than 20,000 financial institutions, 14 million merchants and 600 million consumers are connected in 220 countries. The system facilitates transfer of a gargantuan number of transactions and financial transfers between purchasers and vendors entirely transparent to vendors. Such a robust and efficient transfer system is possible if higher education institutions will become humble enough to put students' success as their top priority. Efforts similar to the above discussion for a better transfer models that are currently in the works include the Bologna model, and Lumina's Degree Qualifications Profile. Likewise these two initiatives are promoting the idea of shared standards in the service of seamless transfers across institutions.

[16] Non-academic costs are those not directly related to instruction, such as administrative and student support expenses, etc.

[17] Baumol, W. and Brown, W., The Economic Dilemma; a Study of Problems Common to Theater, Opera, Music, and Dance. Twentieth Century Fund, 1966. Such views have been strengthened by highly regarded scholars such as economists William Brown, who assumed the presidency of Princeton University, and New York University economist William Baumol. In their seminal study in 1966, they analogized colleges and universities with a string quartet. They asserted: one cannot cut a cellist from a quartet or squeeze more productivity by playing a music piece faster. However, if one reflects back on the technology of the mid-1960s as solid-state electronics was just emerging, some individuals believed it would never replace vacuum tubes. The Darlington junction, which connected two bipolar transistors, was only a decade old and they thought VLSI (very large scale integration) technology was assumed to be beyond practical reach. Today, MP3 iPods demonstrate how easily music can flow; Apple iTunes U open courseware has logged more than 700 million downloads; more than 125 million individuals downloaded MIT open courseware since 2003, the first edX course on electronic circuits offered earlier in 2012 garnered 120,000 downloads; and Facebook built the largest global social network in just a few years.

## Opportunities for open learning and course redesign

Higher education sits in a position of real opportunity. The advent of new information technologies offers exciting possibilities—particularly with the increasing cost of attending college. We have to rethink, reimagine and reengineer teaching, learning and educational delivery systems. At the same time, we must examine assessment approaches and address the very complex and critically important implications for faculty work and professional development. Let's take the highest ideals of the liberal arts university into the global 21st century and build the underlying infrastructure for a future of unbounded learning. Building an infrastructure that supports access to open educational tools and resources will greatly enrich student learning and encourage innovation.

In a June 2005 National Center for Public Policy and Higher Education newsletter titled "Policy Alert," Carol Twigg,[18] from the National Center for Academic Transformation (NCAT), published her findings on the relationship between course redesign, cost reduction and improved learning. Course redesign refers to the process of restructuring how course content is delivered to improve learning outcomes. It may involve the innovative use of technology to enhance learning experiences. The results were based on a study that NCAT conducted in partnership with 30 colleges and universities, which clearly demonstrated the tremendous opportunity to enhance learning quality and simultaneously reduce cost in higher education.[19]

According to this study, 25 of the 30 projects demonstrated significant student learning. Eighteen of the 24 projects that were measuring student retention demonstrated a drop in student failure rate and withdrawal rate. In addition, the projects demonstrated a cost reduction ranging from a low of 22 percent to a high of 77 percent and an overall average cost reduction of 37 percent. The report stated that roughly 60 percent of students at the participating public universities do not complete their degrees in five years. It is more striking to know that half of those students—30 percent of the freshman class—who do not complete their degrees drop out of college during their first year.

Therefore, the first year of college is pivotal in the completion of a college degree, and students' learning experiences in introductory courses are critical. As a result, NCAT concentrated its efforts on redesigning the lower-division courses not only to reduce costs but also to increase student learning and improve retention and gradu-

In light of these advances, the aforementioned string quartet analogy for higher education phenomenon, crumbles, especially if we can demonstrate and assess better learning using these current tools. In fact, with the advent of Internet II, you could have different instruments be in different continents, but still collectively play a musical piece live.

[18] Twigg, Carol, "The One Percent Solution," *Educom Review*, November/December 1995, 30(6). http://net.educause.edu/apps/er/review/reviewArticles/30616.html. In 1995, Carol Twigg wrote an article based on a study about course redesign at the Maricopa Community College District. The study showed that for Maricopa College District the top 25 courses account for roughly 50 percent of community college enrollment and 35 percent of baccalaureate enrollment. Maricopa showed 44 percent of enrollment in these top 25 courses; most community colleges show about 51 percent; four-year colleges show about 35 percent. The baccalaureate 35 percent for the top 25 courses comes from Cliff Edelman's transcript studies, while for a comprehensive baccalaureate institution the percentage will be lower. As an example, at Seminole Community College, 17 courses make up more than 60 percent of its enrollment. In subsequent studies, the center confirmed these percentages with more than 500 colleges and universities by analyzing their enrollment patterns over 11 years as part of the study's redesign programs. The 25 course titles vary somewhat according to institutional type, but in general they include introductory studies in English, mathematics, psychology, sociology, economics, accounting, biology, chemistry, etc. Any institution with a computerized registration system can do such an analysis very quickly. For Maricopa, it included six courses in remedial English and math. The list of the courses: English (5), includes freshman comp, developmental writing and 2 reading; communications (2); mathematics (5); accounting (1); biology (2); chemistry (1); economics (2); philosophy (1); psychology (1); sociology (1); Spanish (1); fitness (1); computing (1); EMT (1).

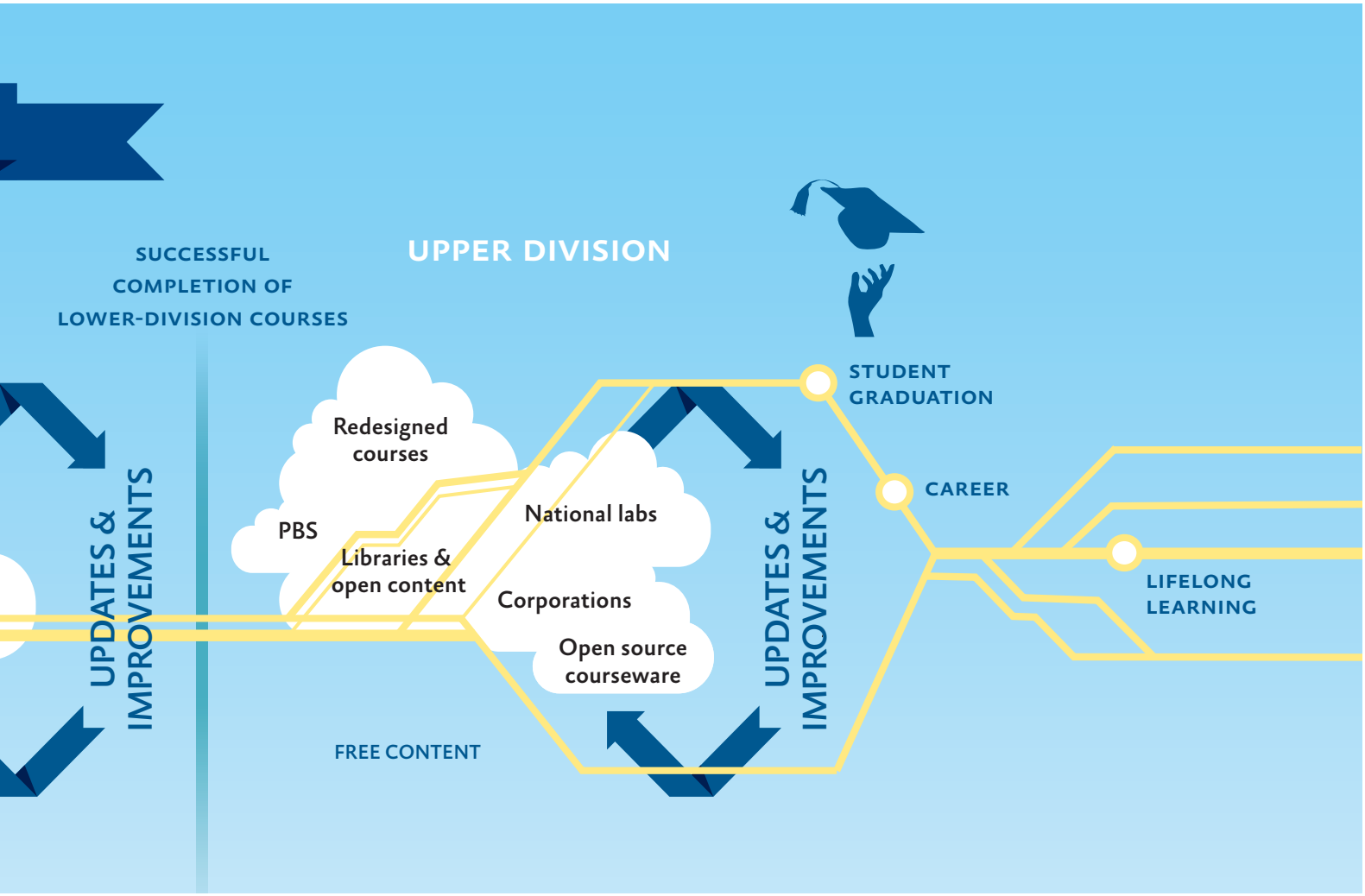
[19] Twigg, Carol, "Course Redesign Improves Learning and Reduces Cost," National Center for Public Policy and Higher Education, *Policy Alert*, June 2005.

## Proposed new model


The figure shows how students can progress at their own pace using one of several learning pathways. Instructors at high schools, colleges and universities may use the open content to enhance their courses. And individuals may use them to prepare for tests or personal enrichment. In any case, these redesigned courses will be free and available to anyone, anywhere.

ation. The study concluded that the redesign of the top 25 courses constituted roughly 42.5 percent of a four-year college education. By extrapolating the average 37 percent cost reduction achieved by the study, NCAT projected a 16 percent (0.425 * 0.37 = 0.16 or 16 percent) reduction in overall cost of college education. Using the total number of students enrolled in these top 25 courses nationally, according to 2003 IPED data, NCAT projected a potential annual cost reduction of more than $9.7 billion for all higher education institutions across the country.[20]

[20] More on the course redesign study at: thencat.org/PCR/Proj_Discipline_all.html




As stated earlier, only 40 percent of students who enter college interested in STEM majors attain a degree in a STEM discipline. A significant percentage of these students switch their majors in the first two years. Another significant benefit of course redesign will be the increase in the persistence of students majoring in STEM, which will result in a sizable increase in the percentage of degrees attained in these areas, especially if significant academic advising and student support is also provided.

Public higher education needs a new teaching model. Embracing a model in which open content is standardized across institutions will make transferring credit more efficient, reduce time to degree, increase student success, including in STEM fields, and may dramatically reduce the cost to students, educational institutions and individual states. This model will also increase the throughput of higher education in general. Implementation will require a series of steps, including evaluation of courses and collaboration to develop policies and outreach to get buy-on. To begin, let's examine the proposed open learning model.

First, based on significant research done by NCAT, assume that 25 to 40 redesigned lower-division, introductory STEM and non-STEM courses will be offered through reliable open courseware and that most institutions adopt these courses. As a specific case for California, the three systems of higher education—community colleges, California State University and University of California—will adopt these courses with a common numbering system.

The next step will be redesigning upper-division programs. As illustrated in the "New Learning Pathways" figure (page 10), each institution, or group of institutions, can build degree programs using a number of possible sources, such as materials already available in open source courseware, learning modules developed by corporations, national labs, public broadcasting services, libraries, etc.[21] With this model, not only can each institution tailor the upper-division programs to reflect its unique identity, each institution would be able to meet the needs of different market sectors without a high investment. Partnering with other entities enables colleges and universities to enhance their agility and meet workforce demands in a very timely fashion.

Redesigning these courses will improve students' persistence and pass rates, especially if there is strong faculty buy-in, advising, assessment and student support services such as tutoring and peer mentoring. The redesigned courses will also be available to students while they are in high school to enhance College Board's Advanced Placement (AP) materials, for independent study, placement test preparation or as refresher courses.[22] In addition, lifelong learners of all ages will be able to take advantage of the free, publicly available redesigned courses.

A considerable amount of collaboration will be required to evaluate content, get buy-in and develop policies for implementing this model. College credit will be obtained if the open course content is used through an institution or degree program. To issue appropriate certifications or degrees, colleges and universities will need to collaborate to design more robust, refined and reliable assessment tools to be able to evaluate the competency of students who take the redesigned courses on their own.

[21] Campuses can look to a variety of resources in the open domain as well as partner with other entities such as national labs, PBS, foundations, theaters, corporations and in-house content producers to build a series of apps for every major. The apps could serve as a hub to bring all of these content sources together and identify what content the students need to learn to attain mastery of the materials.

[22] Students who need more assistance can take these courses in the traditional manner. There are very promising alternative models of remediation available now as well, such as the "Math Emporium" ("How to Structure a Math Emporium," The National Center for Academic Transformation, www.thencat.org/R2R/AcadPrac/CM/MathEmpFAQ.htm) and others, suggesting that struggling students benefit from curricular transformation.

## What can be done now?

- Increase efficiencies by consolidating, redesigning and standardizing the top 25 to 40 introductory, lower-division courses to reduce cost of delivery, make transfer of credits easier and increase the number of graduates.
- Improve STEM graduation rate of all student groups, especially women and underrepresented minorities. Improve the pipeline and graduation rate of STEM majors by utilizing new methods of teaching and learning.
- Use technology to transform teaching and learning and to enhance what great teachers and professors do. Allow instructors to concentrate on learning activities that are enhanced by state-of-the-art content delivery. Dramatically increase access to content.
- Use our colleges and universities as convening leaders to bring together all constituents.

**To remedy the crisis in public higher education, we must reinvent our current approach to teaching.**

## Conclusion

According to a 2010 study conducted by McKinsey & Company, given the projected demand, the states must increase their investment by $52 billion annually. However, as we've noted, most states have been continuously reducing funding.[23] Almost every student ends up taking more than the needed credit hours for graduation if they transfer from one institution to another, wasting billions of dollars. Our nation needs one million more STEM graduates—more than what all higher education institutions currently are likely to graduate—in order to maintain our economic competitiveness. In addition to competency in art, humanities and STEM disciplines, being digital savvy is becoming a key prerequisite for success. And advances in technology, the expansion of online learning and the needs and expectations of tech-savvy students make now the time to embrace the changing role of colleges and universities.

Given the promising results of the course redesign and the new capabilities that open courseware provides, these combined efforts will increase throughput of colleges and universities. As more students take courses at multiple institutions, it makes sense to seek standardized course content and numbering systems across most institutions, at least for the first two years.[24] With the proliferation of such an approach, not only will students graduate faster, the total cost of attendance will drop. And given existing systems, as a nation we can meet the additional one million STEM college graduates within a decade.

The economic health and prosperity of California and the United States depend on the excellence of our public higher education system. We must preserve and build on this foundation by transforming our colleges and universities to address the needs of the 21st century. Open courses aren't going to replace universities or the need for classroom teaching. However, to remedy the crisis in public higher education, we must reinvent our current approach to teaching.

Making these changes will require substantial work and short- and long-term actions. The time to start is now. California's public higher education system has long exemplified innovation and excellence, making it the envy of the world. The crisis we now confront offers an extraordinary opportunity for us to innovate and lead the way once again.

[23] Auguste, Byron, et al., "Winning By Degrees: The Strategies for Highly Productive Higher Educational Institutions," McKinsey and Company, November 2010, 8. mckinseyonsociety.com/downloads/reports/Education/Winning%20by%20degrees%20report%20fullreport%20v5.pdf

[24] An analogy to the current course numbering system in U.S. universities is the way time was set up relative to the position of the sun in Britain in the 1800s. Time was different from one small township to another. More specifically, various areas around London varied by more than 20 minutes from Greenwich Time. These differences were not a major problem before the advent of the railroad industry. In order to have a train timetable, in November of 1840 The Great Western Railway in England adopted a single standard time, namely, the Greenwich Mean Time, which replaced different local times.

## Call to action

We invite you to participate in a dialogue about this paper and our proposed next steps, which include the following:

1) **Implement a new model for California's three public higher education systems**—community colleges, California State University and University of California—to standardize 25 to 40 of the most popular lower-division courses in a range of disciplines. Partnering with industry and organizations, redesign 25 to 40 upper-division courses that make use of existing content. Make all redesigned courses free and publicly available. Test the pilot program in California and, based on results, refine the process and scale for national adoption.

2) **Encourage the development of new ways to assess student learning** to dramatically reduce the need for remediation and repetition of courses. Continue to provide support, resources and recognition to those who develop new ways to assess student learning and widely disseminate their findings and best practices. Entrepreneurs and academics must partner to develop these tools.

3) **Foster new collaborations between California's colleges and universities**, businesses and the community to create innovative programs that blend learning with real-world experience. Lead the way in adopting the best new approaches using technology and collaboration to transform teaching and learning for 21st-century needs.

*Comments, ideas or feedback on this white paper may be directed to reinventingeducation-group@sjsu.edu*

## About the authors

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