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THE COURSE OF INNOVATION:

Using Technology to Transform Higher Education

By Ben Miller

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ABOUT THE AUTHOR

BEN MILLER is a policy analyst at Education Sector. He can be reached at bmiller@educationsector.org

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1201 Connecticut Ave., N.W., Suite 850, Washington, D.C. 20036
202.552.2840 • www.educationsector.org

On a cool, gray evening in October 2009, a group of University of Idaho students began trickling into the basement of a multistory brick building tucked off to the side of a sloping, grass-covered quad. They were there to learn math. But there were no math professors to greet them.

Instead, students quickly spread throughout the room, finding spaces in front of the room's 94 computers or open spots at several tables where they could use their own laptops. Some put on headphones and began scribbling notes as videos and animated diagrams played on the computer screens in front of them. Others studied graphs and worked through problem sets, periodically clicking a mouse to answer questions. No two students were looking at exactly the same thing or working in exactly the same way. But as heirs to their school's pioneering venture in course transformation, they all were sitting at the forefront of 21st century higher education.

The room is known as the Polya Mathematics Center. It opened in 2001, on the site of a discarded anthropology lab, as part of a now decade-old movement to marshal the power of information technology to simultaneously improve student learning and reduce skyrocketing higher education costs. There are now dozens of sites like Polya scattered across the country, at small community colleges and huge research universities and in subjects ranging from Spanish and English composition to chemistry, history, and engineering. And the number of sites is growing every year, as an increasing number of colleges manage to crack the code of higher education productivity by helping more students advance toward degrees while cutting costs in the bargain.

With universities under pressure to increase degree production at the same time that endowments are shrinking and cash-strapped state legislatures are cutting public funds, this would seem to be the kind of innovation that would quickly be adopted far and wide, resulting in hundreds or thousands of Polya-type learning environments, instead of just dozens. But this is not the case. Even those colleges that have used technology to successfully transform some of their courses have left most of their other classes alone.

The National Center for Academic Transformation (NCAT), a small nonprofit considered to be the intellectual center of the technology-based course transformation movement, has labored mightily and with much success to help more colleges bring their undergraduate courses into the modern age. But it has labored precisely because colleges have yet to decide, *en masse,* that adopting a proven method to produce better student learning outcomes for less money is the kind of thing they should naturally do on their own.

The Idaho center, one of NCAT's earlier pilot projects, showcases many of the virtues of course transformation. Students taking intermediate algebra and pre-calculus meet for just one class per week, where an instructor reviews the toughest concepts from the assigned homework and discusses specific math problems. The rest of the time, students take charge of their learning by spending at least two-and-a-half hours in the Polya lab, which is open from 8 a.m. to 11 p.m. during the week and for 13 hours on the weekend. There, they complete computer-based learning modules that present material through short videos, interactive diagrams, and problems to solve. The computer provides immediate feedback, giving hints and guiding students back to relevant course materials when they get stuck. If that's not enough, undergraduate teaching assistants and graduate students are on duty 82 hours a week to provide personalized assistance at a moment's notice. Using a decidedly non-technological system, students place plastic cups on the top of a monitor when they need help. Students come to Polya when it fits their schedule, rather than all assembling at an appointed

hour. And they can move through the material at their own pace, rather than in lockstep with their peers.

Before Polya, introductory math was a significant problem for many University of Idaho students. More than 21 percent of students failed or withdrew from intermediate algebra without completing the course, and only 62 percent passed the course with a "C" or better, creating a major barrier toward college graduation just after enrolling. Today, 70 percent pass the course, and the number of students who withdraw from or fail the course has dropped by 20 percent, all at a per-student cost to the university 30 percent lower than traditional courses, saving the university over $1 million over the last eight years.[1] And that was before changes introduced this year reduced the costs by 50 percent more.[2]

With the help of NCAT, other colleges have had similar success. Ohio State University saved $127,200 by transforming an introductory statistics course, with students averaging 8 percentage points higher on a common exam than peers who took the same course in a traditional format.[3] Virginia Tech redesigned a 2,000-student linear algebra course, reducing course costs from $182,000 to $42,000 without any decreases—and some modest, but statistically insignificant, increases—in student academic performance.[4] Carnegie Mellon University developed an electronic tutoring system for its introductory statistics course, which saved more than $23,000.[5] Students in the transformed course correctly answered questions testing statistical concepts at a rate 30 percentage points higher than those in the traditional offering.[6]

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Course transformation, moreover, is not just for math and statistics—public, private, two-year and four-year institutions have improved courses including visual and performing arts, college composition, and introductory Spanish and cut per-student costs by as much as 74 percent in the process.[7]

But despite the worst fiscal environment for higher education in a generation and mountains of evidence that NCAT-style reforms are effective, just over a hundred colleges out of nearly 7,000 nationwide have worked with the center to transform a course.[8] This failure has broad implications for the way state and national leaders should think about the pressing challenge of helping more students earn an affordable college degree.

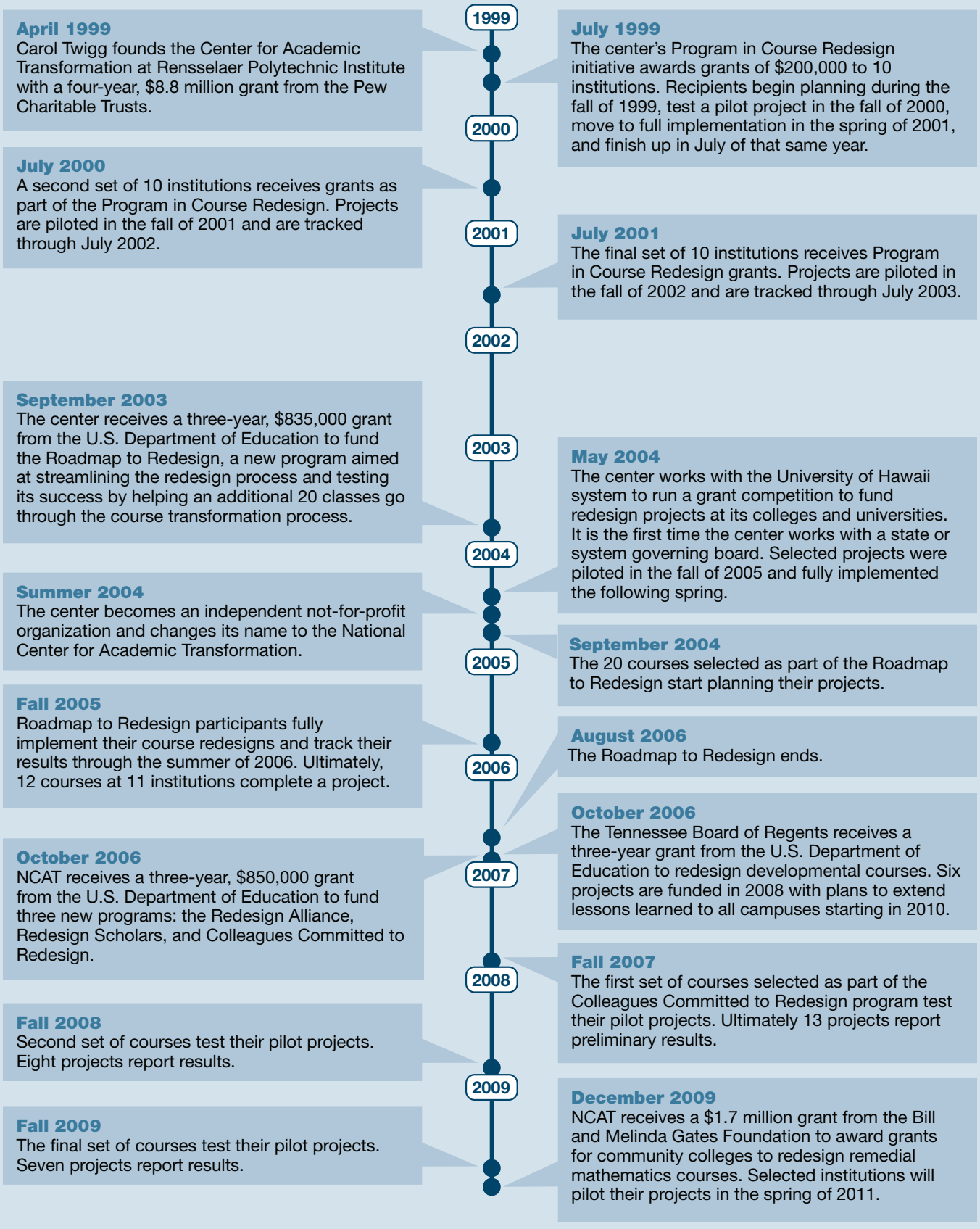
A Center Is Born

NCAT began in April 1999 with an $8.8 million grant from the Pew Charitable Trusts to use technology to improve learning outcomes and reduce costs in large introductory courses at 30 colleges and universities, one course per institution. Though the center is just over a decade old, the ideas underpinning its work reflect the considerable experience and thought of its founder, Carol Twigg.

From the beginning, Twigg's involvement in higher education followed a non-traditional path. Unable to find a professorship following her graduation from the University of Buffalo in 1978 with a doctorate in English literature, Twigg began her career in the administration at Empire State College, the distance education arm of the State University of New York System. Working with students of various ages spread out across hundreds of miles made Twigg attuned to how technology, especially the introduction of the personal computer, could play a large role in changing the way distance education operated. "Personal computing appeared to be a technology that would be accessible to people in their own homes, and that seemed to me to have tremendous potential for helping them communicate easily with each other," she said in a 2007 interview.[9]

After spending several years developing online courses for Empire State, Twigg realized that the increasing spread of computers and the Internet had the potential to change the cost and learning

Figure 1. NCAT's Path to Innovation



Instead of adding pricey computer technology to expensive existing courses, Twigg saw the potential to rebuild the logic and cost structure of higher education from the ground up.

structures of higher education as a whole. From an expense standpoint, technology could be used to automate inefficient activities, such as grading multiple choice exams, allowing labor to be better used elsewhere. It could also make higher education more effective, and thus more productive—tailoring content to specific individuals so that courses did a better job educating more students from a greater variety of backgrounds.

Twigg left Empire State in 1993 to join Educom, a not-for-profit organization where she expanded her work on issues concerning education and technology to a national scale. But this work was not just about adding computers to a course, a process Twigg referred to as "bolting on."[10] Instead of adding pricey computer technology to expensive existing courses, Twigg saw the potential to rebuild the logic and cost structure of higher education from the ground up. Technology, she knew, was a disruptive force that could challenge the typical ideas about how and where learning takes place—and how much learning has to cost. "Only by breaking free of the paradigm of classroom instruction and the tyranny of labor intensive student/faculty contact can we begin to improve productivity through the application of technology to higher education," she wrote in a 1992 article that laid out many of the ideas she brought to Educom.[11]

While working at Educom provided Twigg with a high-profile, national platform, her ideas got little traction on campuses. "I was naïve because I thought colleges and universities would [adopt technology] because it was a good thing to do," Twigg said.[12] So when the Pew Charitable Trusts approached Twigg to ask about how the foundation could invest in higher education and technology, she suggested a large-scale pilot program that would test her ideas about using technology to redesign college courses so that they were not only cheaper to operate, but also resulted in better outcomes for students. Shortly thereafter, NCAT was born.

Uprooting the Higher Education Status Quo

At NCAT, Twigg set out to challenge the centuries-old standard model of college instruction. In its basic mechanics, modern higher education pedagogy is strikingly similar to that used in the earliest European universities: Students attend class meetings where knowledge is imparted through a long, largely uninterrupted lecture. Modern universities supplement lectures with smaller discussion sections, usually led by teaching assistants or non-tenured adjunct professors. But courses are still highly labor intensive, requiring instructors to prepare lecture notes, grade homework and other assignments, and regularly assist students through office hours and by e-mail. As skilled labor has become more costly over time, colleges have become more expensive too.

As the population of students attending college expanded, colleges couldn't afford to offer small, intimate course settings. Large lectures were the answer, with hundreds of students crowded in theater-style rooms. But this exacted a different price—in student learning.[13] And the more college changed with the times, the worse learning outcomes became. College students, for instance, have become more diverse, thus requiring varied approaches to learning. The classic lecture, experienced passively by all students in precisely the same manner, is opposite this approach. What variation exists tends to be random. Many classes, for example, suffer from so-called "course drift," in which the material and grading standards differ greatly depending on the lecturer or course section. Lots of students do not succeed in this environment, and the consequences of failure are severe. Struggling in or failing an introductory course greatly increases the likelihood that students will drop out or withdraw. This, in turn, lowers their chances of earning a degree.

Twigg's goal was to tackle these pathologies of undergraduate education head-on. NCAT gave 30 colleges and universities $200,000 each to redesign an existing course to test whether technology could simultaneously save the schools money and improve learning outcomes. The projects all focused on large-enrollment introductory courses, especially first-year classes in basic subjects that are offered at almost every institution in the country. These offerings made up a large part of students' course loads (30 introductory-level classes account for 32.5 percent of the credits earned by bachelor's degree recipients, according to a 2004 study), and varied little from school to school—meaning that successful redesigns could be easily replicated elsewhere.[14] The 30 projects receiving grants were carefully selected to represent several different types of institutions and disciplines. Twenty-two grants went to four-year public universities, five to four-year private, not-for-profits, and three to community colleges. Thirteen of the redesigned courses were in quantitative subjects, such as mathematics or statistics; six each were in humanities and social sciences; and five institutions elected to redesign classes in the hard sciences.

While the application process was strict and grounded in Twigg's ideas, the participants had significant freedom to establish their own course redesign models. "They literally had to invent the wheel," Twigg said. "We had no idea what they were going to look like." Since institutions tailored their plans to fit their specific needs, no two redesigns looked exactly the same. But the grant projects could be broadly grouped into five distinct course redesign models, with each using technology in different amounts and in varied ways. These models, plus a sixth that came out of a later project, form the foundation of every redesign NCAT has overseen since.

Models of Success

Emporium: Virginia Tech

Multiple rounds of budget cuts and enrollment expansion in the early 1990s placed the math department at Virginia Tech in the difficult situation of needing to teach an additional 5,000 students with a smaller faculty.[15] The department considered cutting courses, but that option was not feasible since math classes are prerequisites for higher-level classes within many other majors. Instead, it took a radical step: Eliminate in-class meetings for lower-level courses, make students more responsible for doing work themselves, and provide greater immediate support to help them.

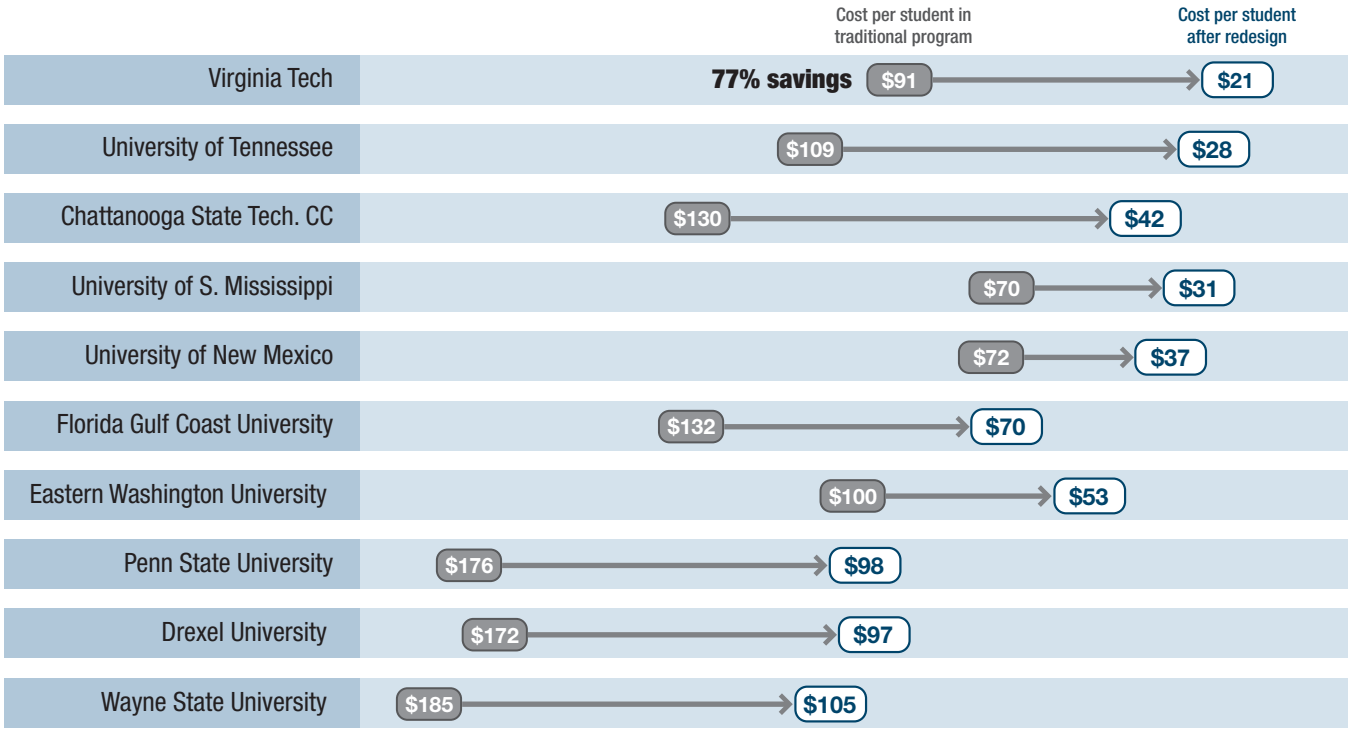
The result is the Virginia Tech Math Emporium, a computer lab much like the Polya Center in Idaho. (University of Idaho officials hired a professor from Virginia Tech to chair their math department and used the Emporium as a model for Polya.) The Emporium, which is built on the site of a bankrupt department store a few blocks from the campus border, provides 537 terminals for students to use 24 hours a day, seven days a week.[16] Rather than listening to lectures, students complete a series of online modules composed of computer-based lesson pages and a question generator, which creates unique problems for students to practice concepts. This setup means students work at their own paces—giving them the option to complete modules more quickly or get more practice if they desire—and do their work whenever it best fits their schedules. Also, the new teaching style actually provides students with more opportunities to get help than were available under the traditional method. Rather than waiting for the few office hours offered each week, students have access to a combination of teaching assistants, instructors, and professors who are on duty at the Emporium for more than 80 hours a week to provide on-demand help for students whenever they need it.

By moving classes to the Emporium, Virginia Tech reduced costs in linear algebra, the first of 11 courses that would eventually be fully or partially based in the facility, from $91 to $21 per student, a cumulative savings of $140,000.[17] And the 77 percent cost savings did not come at the expense of student achievement—students taking courses in the Emporium showed either modest learning gains or similar levels of achievement relative to their peers enrolled in traditional classes.[18]

Replacement: Tallahassee Community College

With roughly 3,000 students enrolling in college composition each year and only so many available instructors and classrooms, Tallahassee Community College in Florida could not afford to teach its introductory writing course in any format other than lectures. But trying to teach composition to a student

Figure 2. Top Ten: Course Redesigns That Saved the Most Per Student, 1999–2006*



***Note:** See Appendix for full list of cost savings at NCAT-supported projects.

body with such a wide variety of abilities meant that a significant amount of class time had to be spent on simple grammar lessons, rather than higher-order writing concerns, such as organization or argumentation. While this could help some struggling students, there was no guarantee that instructors would cover all needed topics. These factors contributed to student success rates of less than 60 percent.[19]

Tallahassee decided to replace in-class grammar and reading comprehension activities with online modules that would teach students these more basic skills. Tallahassee also introduced a diagnostic test to determine which online activities students had to complete. This freed up lecture time, which could be used for class discussions and critique of writing samples. The college also hired SMARTHINKING, an external tutoring company, to provide students with additional feedback on their work through on-demand online tutors. The result was $321,000 in savings, thanks to a 42 percent reduction in per-student spending from $252 to $145.[20] And, using a long-standing rubric developed by the state of Florida to measure college-level skills, the college found that student writing samples from the redesigned course actually improved relative to essays from traditional sections.[21]

Supplemental: Fairfield University

At Fairfield University in Connecticut, seven different professors all taught a general biology course with a total enrollment of 260 students. It was expensive to operate, and instructors emphasized different content based on their experience. For example, Shelley Phelan, an associate professor of biology who worked on the redesign, said she would incorporate recent research findings and new information that went beyond the textbook when teaching parts of the course related to her specialty in molecular cell biology, but would adhere closer to basic examples when discussing areas outside of her expertise.[22] A student with a different professor, however, might have a different experience.

To address these concerns, Fairfield consolidated the biology course into a single section co-taught by two

professors and used technology, such as clickers and laptops, to supplement the learning experience and to make sure the larger setting was not too impersonal. Clickers, small electronic devices that look like remote controls, create opportunities for greater interaction, by allowing professors to solicit student responses during lectures. Professors, for instance, may ask students to respond to a poll or answer a multiple-choice question. Using laptops made the lab part of the course more interactive thanks to software programs that allowed students to generate their own data sets for analysis. The changes reduced course costs by 31 percent.[23] At the same time, student retention of concepts covered in the course also improved, as measured by questions given to students in the required second-year course for biology majors specifically designed to test concepts covered in both the redesigned and traditional class.[24]

Fully Online: Florida Gulf Coast University

Florida Gulf Coast is a relatively new university, having opened its doors in 1997. Enrollment grew rapidly in subsequent years, and the university struggled to find enough qualified personnel to teach required courses like "Understanding the Visual and Performing Arts." Existing faculty were teaching sections of the course in wildly different ways. Instead of following the established syllabus, some lectured at length about French philosophers Jacques Derrida and Michel Foucault, while others read aloud the arts listings of the local paper for more than an hour.[25]

To solve these problems, Florida Gulf Coast moved the entire course online. Students learned course content through a combination of textbooks and supplementary electronic materials, and the university created a large database of potential exam questions so that students could practice for quizzes and exams without having to worry about repeat problems. The course also featured small web-based discussion groups to talk about required essays and other class material. With all materials taught online, labor and facilities expenses decreased significantly, and per-student costs dropped from $132 to $70.[26] Course enrollment rose from 530 in the 2000–01 academic year to 2,400 in the 2007–08 year.[27] Academic performance also improved—an analysis of exams showed that 77 percent of students in the redesigned course earned a grade of B or higher, compared with just 37 percent of students in the traditional course.[28]

Buffet: Ohio State University

Ohio State began requiring students to take a data analysis course in the 1990s, tripling enrollment in the university's introductory statistical concepts course. Not only was the class larger, but the 3,000 students enrolled came from a wide variety of academic backgrounds and learning skills, many of which were not served by the traditional teaching style—a result that could be seen in the fact that nearly 20 percent of students dropped out, withdrew, or failed the class.[29] Dennis Pearl, a professor of statistics, explained the situation in a 2002 article with an allusion to food. "You can make the best roast beef that you can, but a vegetarian is not going to have a good meal."[30]

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Instead of the one-size-fits-all approach, Pearl created a statistics buffet for his course. Students took a questionnaire at the start of the class to determine their learning styles and were then placed into lecture, problem solving, and lab sections based on those results. The redesign also replaced office hours with a new "help room," where a combination of teaching assistants and faculty were on duty 60 hours a week to answer student questions. Achievement and retention in the course both improved in semesters following the buffet's implementation, with students in the redesigned course, regardless of learning style, showing higher average final exam scores than their peers in traditional sections.[31] The number of dropouts, withdrawals, and failures also decreased from 19 percent to 12 percent.[32] Simultaneously, per-student costs decreased by $48, resulting in savings of $127,200.[33]

Spreading Success and Scaling Up

With the success of the course redesign models, NCAT passed its first real test—the grant program proved that Twigg's ideas worked. Of the 30 institutions that received Pew-funded NCAT awards from 1999 through 2003, 21 fully redesigned an entire course, reducing costs by 40 percent on average.[34] In total, these courses enrolled nearly 37,200 students and saved an estimated $2.4 million.[35] All but two of the fully redesigned courses also registered some form of improved student learning outcomes.[36]

But proving a concept and convincing people to adopt it is not the same thing. Several grant recipients piloted a redesigned section of the course but never expanded the changes to the entire class. On other campuses, such as the University of Alabama, which implemented its own Math Emporium, the administration had to overcome strong faculty skepticism to convince them to test the redesign. In other instances, faculty who supported the redesign had to deal with administrative hurdles, such as securing additional classroom space or getting the registrar to award credit for a class that did not have the traditional meeting structure. And when the projects did succeed, they were often ignored by other departments on campus (even those that faced similar budget shortfalls or low passage rates) and by faculty in similar departments at other institutions.

In order to spur widespread adoption, Twigg turned her attention to spreading the models developed by the first round of projects to other schools, and to overcoming the institutional roadblocks that made schools unlikely to adopt the models on their own. The first 30 projects had required as long as two years to develop and had received significant outside support—which was important to participants, but served as an easy excuse for other institutions to explain why they could not take on their own initiatives. Twigg and NCAT's next step would thus have to show that the cost and time concerns could no longer be used as an excuse.

With $835,000 from the U.S. Department of Education's Fund for the Improvement of Postsecondary Education, NCAT established a new program in 2003, known as the Roadmap to Redesign.[37] The Roadmap focused only on courses in pre-calculus, psychology, Spanish, and statistics—the disciplines that had the best results from the initial projects. The goal was to use the best practices from the initial participants to create new models that institutions without outside financial support could adopt. NCAT also brought together representatives from the initial projects to share what they had learned, including compiling lists of available software and other useful materials. By giving participating institutions specific lists of redesign models, cost saving strategies, student learning assessment tips, common implementation issues, and most effective software, NCAT hoped to reduce the trial and error that slowed down earlier projects.

The center launched a 20-course pilot program in the spring of 2005 to test its streamlined process. Ultimately, 11 institutions implemented 12 projects, which included six pre-calculus courses and two each in psychology, Spanish, and statistics. Eight of the projects chose the replacement model, similar to Tallahassee Community College's composition course redesign. And four used Virginia Tech's Math Emporium model.

The Roadmap was a success: The shorter and less expensive process still yielded cost savings with improved or constant learning outcomes. The 12 projects all reported double-digit percentage cost savings, with an average reduction of 33.5 percent.[38] Six of the redesigns reported statistically significant

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learning gains, two reported some increase, and the rest had no significant change.[39]

While the new program showed that cost and development time were not legitimate excuses, an evaluation of the program raised new concerns that needed to be addressed. A review revealed communication difficulties between new participants and the teams of experienced redesign faculty as well as a lack of collaboration between the two groups.[40] "Participants clearly valued on-site collaboration within their own departmental teams … as well as being part of a larger national 'movement'—but this was not the same thing as collaborative learning involving experts or one another," the evaluator wrote.[41]

In order to address these new concerns, the center started the Redesign Alliance, a dues-paying group of institutions, university systems, community college districts, publishers, and corporations engaged in redesign efforts. Turning this previously diffuse group into a linked community made it easier for experienced redesign leaders to share best practices and discuss ways to improve their projects, while also spreading the idea to other institutions. To help new redesign institutions, the center created a group called the Redesign Scholars, which included 19 of the most successful redesign leaders who agreed to play a more formal and involved role in counseling and assisting new projects in their discipline.[42] To test if using Redesign Scholars improved knowledge sharing from old to new participants, the center held another three-round grant competition that aimed to help 20 new courses pilot redesigns each year, beginning in 2007. All told, 28 of the planned 60 courses piloted a redesign, with 13 in the first year, eight in the second, and seven in the third.[43] The final round of pilot projects launched in the fall of 2009 and the initiative's results are forthcoming.

State- and System-Based Initiatives

In addition to spreading the models to new institutions, Twigg and NCAT pursued a scaling-up strategy through a different venue. Starting in 2004 with a handful of projects at the University of Hawaii and the Ohio Learning Network and expanding in 2006, NCAT began a series of system- and state-based initiatives that tried to speed up the pace of redesign adoption by leveraging the power and authority of higher education governance structures. Having the impetus for redesign come from chancellors or boards of regents, rather than lone, ambitious professors or departments, meant bureaucratic concerns or criticism from other faculty could be overruled from above.

One state-based group that NCAT worked with was the Tennessee Board of Regents (TBR), which hired the center as a consultant on redesign work in 2006. TBR oversees the sixth-largest higher education system in the country, serving 180,000 students in six universities, 13 community colleges, and 26 technology centers.[44] Many of the Tennessee students were not fully prepared for college-level work, and 40 percent of those in the university system (as well as 75 percent of those attending community college) needed to take not-for-credit developmental courses in writing or math.[45] The system spends over $25 million per year on teaching skills that should have been learned in high school, and projected enrollment trends suggest that these courses will grow 30 percent by 2020.[46]

Concerned about this obligation, TBR applied for and received a $739,040 grant from the U.S. Department of Education to work with NCAT and the Education Commission of the States to redesign developmental classes at its institutions.[47] TBR funded four redesigns in developmental math and two in developmental reading with the idea that successful projects would be replicated at the system's other campuses starting in 2010. The message was "don't let any limitation in resources and current practice stand in your way," said Treva Berryman, the associate vice chancellor for academic affairs.[48]

Austin Peay State University in Clarksville, Tenn., rose to the challenge. Here, about half of freshmen took developmental courses. Harriett McQueen, the dean of enrollment management and academic support who oversaw the institution's redesign, used the TBR grant to try a bold gambit: Eliminate developmental classes entirely. The plan initially met with some opposition from Austin Peay's faculty, particularly those teaching developmental courses. It also raised concerns among the instructors who would now have to teach students who had previously been assigned to developmental courses. But as Twigg had hoped, working from the top down had advantages: With the support of the regents behind it, the plan moved forward.[49]

Austin Peay's redesign, a sixth model known as linked workshop, enrolled students who would have been in developmental studies in the same introductory math and writing courses as their peers. But these students were required to complete two additional hours of lab time each week. These meetings, known as structured learning assistance workshops, included individual tutoring, group work, and personalized computer-based instruction.[50] The developmental-level students no longer had to spend time and money sitting through a class that gave them no college credit. They could immediately enroll in courses that counted toward their degrees.

The use of technology in the workshops gave students more personalized assistance than they would have received in a typical developmental course. In math classes, students with low entrance exam scores took a diagnostic test to identify which course concepts they did not understand. And because instructors knew what students were weakest in, class time could vary depending on what students needed to improve. For example, during a mid-October visit, a small group of students crowded around a whiteboard at the front of the classroom where the workshop leader taught a lesson on percentages and variables. In past years, all the students in the room would have had to sit through the lesson. Thanks to the diagnostic test, though, students who did not need help in this area did not have to spend unnecessary time on it. Instead, they spent workshop time completing computer-based exercises on the material they actually did need to learn.

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To ensure workshop participation, students can only pass the course if they earn at least a C *and* have satisfactory workshop attendance. In addition, they must demonstrate that their math skills are up to the college level, by passing a computer-based module and subsequent test for each concept they failed on the diagnostic test.

Though successful, redesigning developmental education at Tennessee institutions did face challenges. The regents ran into unexpected difficulties because some of the faculty teaching the courses targeted for transformation had been awarded tenure. Berryman described one course redesign meeting where a tenured developmental faculty member argued the changes would interfere with his academic freedom. This was a surprise to TBR, since it mandates the content and structure of developmental courses and views them as a student support service. "My answer to him was TBR has indeed mandated that it prescribe every aspect of developmental studies since it was created in 1984," Berryman said. Campuses also worked around this issue by finding new responsibilities for tenured faculty who were affected.

Some of the mathematics faculty at Austin Peay also raised concerns about the redesign. "It created some real issues in our classes because all of a sudden, you're asking a faculty member to teach a class, a college-level class, at the same level he teaches his other college-level classes, but oh, by the way, all of the students in the class are academically underprepared," said Nell Rayburn, a professor of mathematics who helped with the redesign.[51] Even after the change some faculty still complain about the switch, citing concerns about teaching college-level material to unprepared students.

And today, not all students buy into the change. Kimberly Noble, a freshman majoring in radiology at Austin Peay, said she liked being able to complete some parts of the course online, but wished she had additional help for explaining the things not covered by the computer-based assistance. "I wish we had an actual teacher in the class," she said. "I wish somebody was there to show us how to actually do it, and then we could learn it that way, because I see how they get the answer, but I don't know [what to do] in between."[52]

Still, the numbers show striking improvement. Only 53.3 percent of Austin Peay students with poor math skills who enrolled in 2005 passed their developmental courses within two years.[53] Just 30.2 percent of developmental math students completed a for-credit math course within two years, and 65 percent never even attempted one.[54] After the move to transformed sections in 2007, 67.3 percent of entering developmental math students passed the same for-credit math class they could not have gotten into two years earlier.[55]

The reforms also resulted in cost savings for both the university and students. Austin Peay estimated that it saved $41,500 and 70 hours of class space from its redesign and also took in $72,200 in additional revenue from having students pay full tuition plus a $75 fee for workshops.[56] But since students no longer had to take non-credit courses they still ended up with net savings of between $887 and $485 depending on how far behind they were upon enrolling.[57] (See sidebar, "Lower Costs, Unchanged Tuition," p.12.) Everybody won. The success prompted the school to try a similar redesign of its introductory English courses. The results were similar: Prior to the redesign, 54.4 percent of developmental students completed the required introductory English course within two years; after the redesign, 75.5 percent did.[58]

While TBR only targeted developmental courses at its institutions, other states and systems that participated in NCAT's scaling-up strategy took a broader approach. They also relied on different funding sources. The Arizona Board of Regents (ABOR), for example, used an existing $500,000 annual grant program to provide grants of $40,000–$50,000 to redesign courses at the three public universities it oversees. Working with NCAT to select recipients, ABOR asked grantees to transform high-enrollment undergraduate courses that suffered from poor student success rates. The 10 completed projects fell across a wide spectrum, including geology, public speaking, women in society, chemistry, and biology. These redesigns saved a total of $1.2 million, or a 37 percent reduction in per-student costs.[59] But savings did not come at the expense of student learning—five projects had statistically significant learning improvement, two had equivalent scores in a redesigned course that was more difficult than the traditional counterpart, and three showed no change in performance.[60] Financial difficulties in Arizona have made it difficult to gauge whether ABOR will be able to continue funding more redesign projects, but the three universities continue to stay involved with redesign in different ways, according to Maryn Boess, the ABOR grants manager who oversaw the project.[61]

Not all students buy into the change. Kimberly Noble, a freshman majoring in radiology at Austin Peay, said she liked being able to complete some parts of the course online, but wished she had additional help for explaining the things not covered by the computer-based assistance.

The fate of other redesign projects, such as one led by the Mississippi Institutions of Higher Learning (MIHL), is also unclear. That project began in 2007 when Thomas Meredith, then commissioner of the MIHL, convinced the organization's board to set aside $1 million for course redesign grants at the eight public institutions it oversees. Sixteen projects in subjects such as algebra, Spanish, and biology, ultimately received awards between $50,000 and $100,000. Institutions ran pilot projects in the spring of 2009 and then all but one tested a fully implemented redesign in the fall of that year.

The MIHL board is waiting to hear project results in the spring of 2010 before deciding whether to continue redesign funding. But other events could complicate the program's future, such as the departure of Meredith, who retired in 2008. According to Twigg, high-level leadership turnover can create problems for state- or system-based projects. "Leadership in these systems change so frequently that we started out in several of these states where we had a committed chancellor or commissioner and both of them are gone now," she said. Instead, they

were replaced with a "whole new administration that had nothing to do with it and knows nothing about it." Such a situation requires repeating the lengthy groundwork needed to overcome initial skepticism of course transformation and also puts the project at high risk of cancellation.

Lower Costs, Unchanged Tuition?

Projects from the National Center for Academic Transformation provide a number of benefits for students—opportunities to pass courses faster, work at their own pace, and receive greater help than they would in a traditional setting. And while these results come at a cost that is thousands of dollars less for a given institution, these savings rarely end up in the pockets of students.

Students at Austin Peay University ended up with a small net savings when the school eliminated developmental courses, but this is not typical. Most redesign projects helped institutions deal with financial pressures facing a particular course or department, but did not create enough savings to be applied elsewhere. Virginia Tech's Math Emporium, for example, kept the department from having to reduce its offerings in the face of budget cuts. The University of Alabama and Florida Gulf Coast, meanwhile, used savings to cope with significant institutional enrollment increases.

Though students do not receive direct tuition relief from redesigns, they do derive financial benefits from a successful project if it makes them more successful, such as helping them avoid failing and subsequently repeating a course, which requires additional tuition dollars. And in the case of remedial education, failing can have the steep cost of delaying a student's entire educational progression through for-credit courses.

Saving money by way of educational success is a valuable benefit, but it does not address the skyrocketing tuition costs that threaten to put college out of reach for many students. For redesigns to serve this purpose, they will have to become more widespread, involving more faculty and departments and ultimately saving more money. Campuses save at most a few hundred thousand dollars from redesigns each year, which is not a lot of money when shared across an entire student body. Also, cost savings typically stay within a department, where faculty view it as money for them to use—a reward for making certain sacrifices. The Ohio State statistics department, for example, used cost savings from its redesign to free up more faculty research time by reducing their teaching load. Taking the money away from departments and applying it to student costs, therefore, eliminates a major incentive for faculty to engage in a cost saving project.

From Start to Sustainability

By 2006, the center had created and refined a successful redesign process. With more than 50 institutions having participated in a course redesign, NCAT had proven not only that its methods worked, but that they could be used without the luxury of expensive grants and could be implemented in a relatively short timeframe.

In all, NCAT has amassed a growing and increasingly complex portfolio of projects, each with a particular internal logic and source of funding. Over time, a new challenge to bringing productivity-enhancing innovation to scale has emerged: sustaining its success. Because the NCAT process is heavily focused on initial piloting and implementation, the center does not play a significant role in projects after the first few semesters. Instead, schools are left in charge of ensuring that redesign work is sustained.

But preliminary success does not necessarily guarantee that cost savings and improved student learning results will continue under their own momentum. The redesign projects that have grown in enrollment or spread to other departments often maintained some, if not all, of the same initial factors that made their projects work. For instance, there has been little personnel change among those teaching and supporting redesigns at Virginia Tech, University of Alabama, Ohio State, Portland State, the University of Idaho, and several other institutions. These individuals have built up significant knowledge about how redesigns function and the learning theories that make them successful. According to Robert Sanders, a professor of Spanish who led a redesign at Portland State, leadership stability has a lot of advantages. "If you have a lot of staff turnover, a lot of institutional memory is lost, so one person after another has to learn all of the same mistakes over again," he said.[62]

By contrast, frequent leadership turnover at Florida Gulf Coast created difficulties for its redesign. Because of staff promotions, the project has had three different leaders since its inception and no longer has as strong a link to the administration.[63] Such frequent turnover means there is no long-term advocate for the course, one that can speak from the authority of having overseen it from the very beginning. This disappearance of vertical support and lack of

consistent leadership has exposed the redesign to departmental in-fighting and broader faculty criticism.

Redesign programs may also work against departments that must compete amongst each other for resources. Because Florida Gulf Coast's arts course is taught to all undergraduates online, the department does not need as many faculty members as it would if it were to offer the course face-to-face. As a result, it has a smaller presence on campus than it would otherwise, giving it a disadvantage when competing with departments over classroom space, scheduling times, and other shared resources. This is a case where the incentives driving individual, autonomous academic departments run counter to the interests of the university as a whole. Departmental prestige is measured in dollars and personnel. Efforts to teach with fewer professors and less money can quickly run against the ambitions of influential department chairs.

And even in existing redesign projects, once the initial pressures to pursue reform have passed, officials can give in to calls for a return to the traditional format. The University of Tennessee's Spanish redesign, for example, initially used online workbook and grammar activities to replace one day of class time a week out of concern that the course would be cut if it did not save money. Once it became clear that the course was safe, instructors successfully lobbied to add back the extra day.

Another obstacle to sustainability is the gap between faculty and administrators that appears in all of NCAT's redesigns. Because long-term management of the redesign is handled by faculty, who have a greater interest in student learning and play a minimal role in budget determinations, programs are unlikely to still monitor cost savings in a demonstrable, external manner.[64] Most faculty have no incentive to track costs, except when faced with potential funding reductions, so they do not regularly keep track of this information. Even the reporting of learning information typically decreases without an external entity requiring its documentation. A lack of long-term documented cost savings can make it harder to defend a project against its critics, increasing the likelihood that it will be eliminated.

Changing the Equation

As of early 2010, Twigg remains a strong evangelist for course transformation, and the center's profile has increased in the higher education sector. NCAT hosts an annual conference in Orlando, Fla., that routinely draws hundreds of practitioners from institutions around the country. Regional workshops on specific topics, such as remedial math instruction, are held before packed rooms with representatives from dozens of area colleges and universities. Interest from policymakers and philanthropists remains strong. The center has been featured and mentioned in several books and articles, and was favorably cited in the final report of the U.S. Secretary of Education's Commission on the Future of Higher Education. "The results," said the commission, "speak for themselves: more learning at a lower cost to the university."[65] In December 2009, the Bill and Melinda Gates Foundation announced funding for a new $1.7 million NCAT project, which will focus across institutions in a specific discipline—in this case, developmental math education.[66] Called Changing the Equation, the program will provide $40,000 grants for at least 25 community colleges to redesign their developmental math offerings.[67]

But the fact that Twigg has continued to develop new strategies for bringing course transformation to scale underscores the numerous barriers to widespread adoption occurring on its own. Despite the tremendous fiscal strains that colleges are now experiencing due to declining state support, falling endowments, and shrinking family income, colleges and universities still have to be paid to implement reforms that will save them money. They still have to be cajoled into fixing introductory courses where large numbers of students routinely fail. The NCAT story is one of significant but still limited success, despite the odds. That makes the odds themselves all the more important to understand.

Reluctance to change is hardwired into many of the structural features that define today's colleges and universities, and it will be very difficult to achieve large-scale reforms of any sort without dealing with them directly. The root of the dilemma lies with the decentralized and inherently conservative nature of the modern higher education institution.

Table 1. Six Models of Success

Key Features	Examples	Cost Saving Strategies
1. Emporium		
• Substitutes classroom instruction with self-directed computer-based modules • Work completed in large computer lab constantly staffed with lots of teaching assistants, tutors, and professors for assistance • Software allows for repetition so students actively work through problems and take responsibility for their own learning	• The Math Emporium at Virginia Tech • University of Idaho's Polya Mathematics Center • University of Alabama's Math Technology Learning Center	Greater reliance on teaching assistants and tutors cuts down on the need to use expensive faculty. Use of large computer lab lessens demand for classroom space and makes it easier to expand enrollment.
2. Replacement		
• Replaces some material previously taught in-person with computer-based or online modules, resulting in fewer classroom meetings • Moving basic instructional content, such as introductory Spanish grammar lessons, online allows for classroom time to focus on more substantive issues that are best done face-to-face, such as improving conversational skills • Online material can be tied to students' learning needs and allows them to learn content through repetition and practice	• College composition at Tallahassee Community College • Intermediate Spanish transition at University of Tennessee • Elementary statistics at Penn State University • Economic statistics at University of Illinois at Urbana-Champaign • Introductory Spanish at Portland State University	Reduced classroom time creates opportunities to substitute expensive faculty labor for electronic exercises.
3. Supplemental		
• Use electronic activities to supplement in-class learning, improving students' depth of understanding and ability to pass the course • Amount of time spent in class remains unchanged, though section size can increase • Classroom content may or may not be altered to reflect material covered in new online activities	• General biology at Fairfield University • Statistics at Carnegie Mellon University	Larger class size means lower per-student spending on instructors; improved student passage rates means reduced costs associated with course repetition.

"This is not replacing what you do, this is not replacing you. It is freeing you to really work on the writing process to really engage students in that process—to have time in that classroom for peer review, for brainstorming." —Sally Search, dean for academic support programs, Tallahassee Community College

Higher education governance tends to be light. Boards of regents, chancellors, and other high-level system administrators generally only have control over what classes and offerings are taught, not how those courses are actually run. Any attempt to overstep these boundaries is often met with suspicion from campus leaders and faculty. In the case of private institutions, there is no authority beyond the institution's board of trustees that can exercise control. And there are also no guarantees that governance orders will be followed exactly as desired when they reach institutions.

The internal workings of colleges and universities are even more decentralized. While there is some bureaucracy to handle issues such as course scheduling, credit assignment, admissions, human resources, and capital planning, the core enterprise of teaching is left to individual departments. And NCAT is fundamentally about the transformation of

Table 1. Six Models of Success, continued

Key Features	Examples	Cost Saving Strategies
4. Buffet		
• Provide students with options for lecture and lab sections that cater to different types of learning styles • Content is the same across all sections, but the way it is taught varies • Creates opportunities for both small group learning and computer-based activities completed outside of class	• Statistics at Ohio State University	Students who select out-of-class learning options reduce expenses on instruction and classroom space. Tailored instruction improves student outcomes, lessening cost of repeating a course.
"When we first did the first pilot, we had about 300 people in each group and so we had a multiple choice satisfaction instrument and we also allow[ed] for open-ended comments. Out of the open-ended comments, around 50 students commented about the buffet and all 50 were positive. You ask yourself who's going to say 'I don't want the choice?' " —Dennis Pearl, professor of statistics, Ohio State University		
5. Fully Online		
• Replace all class meetings and face-to-face interaction with Internet-based activities • Students use web software to work through material on their own, allowing for repetition to master an idea • Frequent repeatable quizzes are used to test progress and knowledge	• Understanding the visual and performing arts at Florida Gulf Coast University	No need for physical space; online software reduces role of instructors; easy to expand enrollment.
6. Linked Workshop		
• Eliminate remedial courses and place developmental-level students in traditional credit-bearing introductory classes • Require developmental-level students to attend supplemental workshops that use a combination of traditional instruction, small groups, and computer-based activities to teach them the skills and content knowledge they need to do collegiate work • Make students demonstrate success in both the traditional course and workshop in order to receive course credit	• Developmental writing and mathematics at Austin Peay State University	Entire elimination of remedial courses means lessened demands on personnel and classroom space. Enrolling students in college-level work improves retention, lessening costs associated with dropouts.
"When you take these developmental, non-credit courses, what are [students] focused on? Completing that course. It's not until later on that they are going to enroll in the course that matters. But with our model, they are completing their core course while they are addressing deficiencies. There's none of this 'later on' about it." —Harriett McQueen, dean of enrollment management and academic support, Austin Peay State University		

teaching. Within departments, authority is further diffused to individual professors who take ownership of their courses and often vehemently oppose efforts to interfere with their visions of teaching. This sets up two separate power structures composed of those who have the ability to change the academic structure of courses and those who have the administrative authority to make those courses work within the larger university curriculum. This is why all NCAT projects require the involvement of both faculty and administrative personnel.

This diffuse power structure creates other obstacles to the spread of innovation. Because each department acts as a self-contained unit, there is little dialogue between faculty members who teach in different academic disciplines. As a result, if a mathematics redesign has attributes that make it attractive to the chemistry department, there is no clear communication channel to share that idea.

Also, the lack of a coordinated approach to undergraduate education at the state, system, university, college, and departmental levels means that innovators tend to quickly run afoul of university bureaucracies. Presidents, provosts, and high-level administrators can be reluctant to grant special dispensations in the usage of classroom time, awarding of academic credit, or purchase of extra technological resources for fear that similar privileges will have to be granted to all other courses. They can, in theory, override the objections of registrars and information systems offices. But they are unable to force a professor to redesign and then teach a course exactly as they desire. The only way to bring innovation to scale and sustain it over time, therefore, is to establish strong communication and shared commitment between faculty, department leaders, and campus administrators. Such coordination is not a traditional strength of higher education.

Colleges also tend to have poorly aligned incentives with respect to the cost of education. Professors care about what gets taught in the classroom, while administrators are concerned with costs and capital expenditures. Few, if any people are strongly concerned with both of these elements, and even more rarely will that person be the faculty member leading what goes on in a classroom. Even if departments do have some responsibility for budgeting and financial matters, there is no guarantee that the benefits of adopting reforms will accrue specifically to them, further lessening the incentive for action. The people in the best positions to implement productivity-enhancing reforms, in other words, often have no financial incentives to do so.

Finally, modern universities are not set up to measure teaching quality or student improvement. “Virginia Tech is a research university, and to be honest there really aren’t, especially in the hard sciences, a lot of faculty dedicated to teaching,” said Michael Williams, an associate professor of mathematics at Virginia Tech and the director of the school’s Math Emporium.[68] “Obviously no one goes into the classroom thinking they are going to do a bad job, but they generally aren’t going to go the extra mile to make something good.” This is the result of a training and reward system that is geared entirely toward research and content knowledge, rather than quality instruction. Training for graduate students, even those who wish to become faculty members, focuses on conducting research and putting together a dissertation. Instructional training is expected to come through a few semesters of serving as a teaching assistant. Even once someone becomes a faculty member, their future compensation, success, and receipt of tenure are all predicated on being able to produce research papers, journal articles, and books. A quality teacher with a short publication record will not advance as far as the prolific author who treats classroom instruction as an occasional annoyance.

Reluctance to change is hardwired into many of the structural features that define today’s colleges and universities, and it will be very difficult to achieve large-scale reforms of any sort without dealing with them directly.

Learning From Example

NCAT is the latest innovative idea to hold potential for transforming higher education, but it surely is not the last. As such, future innovators would do well to learn from its efforts. What the NCAT example makes clear is that building a better mousetrap, or introducing a successful innovation, will not have the higher education world beat a path to an innovator's door. The industry has powerful built-in defenses to new ways of working, regardless of how proven or important. But what NCAT's experience also shows is that when change does occur it is the result of a coordinated, multi-dimensional effort, one that considers both how to start and sustain a project, as well as how to spread it across campus and to other institutions.

Starting and Sustaining a Single Redesign

1) Take Advantage of Acute Short-Term Problems

Inaction is the path of least resistance in higher education, and faculty need a very strong reason to do anything beyond minor tweaks to their curricula. Though it varied by institution, almost every project selected by Twigg and the center offered a solution to an immediate and pressing problem of cost or learning outcomes. At Virginia Tech, this concern was budget cuts and enrollment growth. For the University of New Mexico, where officials used the supplemental model to redesign general psychology courses in 2001, it was low passage rates, especially for minority students, which appeared to be contributing to a high drop-out rate.

The push for change does not have to come from within the institution. Though Austin Peay recognized the need to do something about its developmental studies courses, it was not until the board of regents passed regulations banning developmental courses at four-year institutions that the school felt it both had the obligation and the authority to act.[69]

2) Connect Faculty and Administration

Redesigns usually require either special assistance or some exemption from institutional rules—

Though it varied by institution, almost every project selected by Twigg and the center offered a solution to an immediate and pressing problem of cost or learning outcomes.

changes that faculty cannot implement without the involvement of higher-level administrators. But soliciting administration support is difficult for most professors because there is no clear channel of communication between them and the officials who have the necessary authority. As such, any institution applying to work on a redesign with the center must demonstrate that its project will involve some technology personnel and other administrators who will make the project part of their agenda. Proposals that try to pursue redesign by a "go-it-alone" approach are quickly dismissed.

Ensuring higher-level involvement solves many communication issues and provides other benefits to redesign projects. At the University of Idaho, former President Robert Hoover's support for the Polya Mathematics Center blunted criticism because there was an understanding that the project was important to him.[70] Administration involvement can also help assuage initial faculty concerns. For example, the University of Alabama math department initially objected to proposals to establish a Math Emporium because of concerns that students would not be successful and learn enough to do well in future traditional courses. But they eventually came around after the dean of the College of Arts and Sciences brought instructors on a trip to the Virginia Tech Emporium and explicitly agreed to stop the project if it did not produce better student outcomes.[71]

3) Strong and Consistent Leadership

Preparing for and implementing a redesign requires a great deal of time and effort. As Monte Boisen, the chair of Idaho's math department put it, "you have

to have a core of people who will fall on the ground dead before they let this thing fail. You cannot do this with the normal level of effort."[72] Having one person or a small group of people willing to put forth this effort is a crucial component of redesign success for several reasons. Taking charge of a project creates a sense of investment that will encourage leaders to work harder to make sure a project functions. It also establishes them as the point people who can develop lasting relationships with administrators and people in the office of technology or registrar so they do not constantly have to battle for new computers or schedule changes.

Dedicated redesign personnel also serve as truth tellers to disprove unfounded criticism. Boisen and Kirk Trigsted, Polya's director, both said they used to receive frequent complaints about Polya from advisers who based their critiques on incorrect information they heard from students. Because both of them have a vested interest in the center's success, they have the motivation to respond and disprove false claims. "Parents who call and complain are one of my delights because they always end the conversation with 'Oh I wish we had that when I was in school,'" Boisen said.

4) 'Scuttle the Boats'

Because higher education's decentralized structure means professors, departments, offices, and the administration each have their own competing agendas and visions for how teaching should be conducted and a university should be run, any change in the system will cause someone to push for its repeal. If the change is small, such as placing a few computers in a room, then it can be very easy to go back to the old ways. But in the case of larger reforms, such as eliminating traditional math instruction and going to an Emporium model, backtracking is a costly proposition that requires throwing out a new set of content, teaching goals, software, and all other types of up-front investment.

Engaging in large-scale changes has helped a number of redesign projects overcome criticism, both at the beginning and even several years after implementation. At Austin Peay, there was no old option to go back to—"we scuttled our boats," as Rayburn phrased it. Boisen expressed similar sentiments about how big changes strengthen reform. "The one factor about this that will stop somebody from saying 'I don't want to do this anymore, let's go back to classrooms,' is they can't afford it," he said.

Though redesign does not protect courses from departmental or institutional power politics, significant cost savings can provide some insulation. While moving Florida Gulf Coast's visual and performing arts course offline and back into the classroom would boost the department's presence on campus through the need to hire more faculty, a return to the traditional setting would entail a prohibitively expensive four-fold increase in costs.[73] Likewise, keeping course expenses low also protects the class against complaints from more strictly career-oriented departments on campus that feel their students should not be required to take an arts course.[74]

5) Benefits for All

Because redesigns require the involvement of administration and faculty, these projects need to produce results that satisfy both parties. In the case of administrators, this means reduction in expenses or the ability to increase enrollment without additional cost. But such outcomes are not enough for faculty, who care more about student outcomes. Achieving cost savings at the expense of student learning or academic gains at a higher price will leave one party unsatisfied and can threaten the entire project.

For example, Portland State reversed several of the changes brought about by its redesign—including replacing some classroom time with online chat rooms—because there was no perceived benefit for the faculty. "At the end of the day, reduced seat time didn't save me, the program, or my department anything," Sanders said. "It saved the university some rooms, on some days that generally went unused because they were saved in such a format that no other class is going to move in."

Spreading Redesigns Across a Campus

1) Link Projects

The costs of a redesign may dissuade individual departments from deciding to pursue reform. Purchasing computers or setting up lab space results in upfront costs. And keeping these facilities staffed

may be difficult for smaller departments that do not have a lot of teaching assistants. One way to lessen expenses is to have departments in different subjects work together to create spaces they can all use.

Penn State University, for example, has done this by creating a dedicated testing center where students from a number of disciplines and classes can come together and complete computer-based exams or quizzes. Because no one has to cover all of the center's costs, it can provide 10,500 testing slots each week—making it possible for both large and small departments to make use of it.[75]

2) Mini NCATs

It can be difficult for departments to find the funds necessary to cover initial startup costs for a redesign. Thus, small institutional-led redesign competitions, similar to the NCAT process but on a lesser scale, can play an important role in helping spur innovation on a campus. Small upfront stipends also can add legitimacy to a project and help faculty make the case for dedicating some of their time to a redesign.

Last year, for example, Tristan Denley, the provost and vice president of academic and student affairs at Austin Peay, ran a small competition using funds from a federal grant to provide $4,400 stipends for five redesign projects in courses such as speech, statistics, chemistry, and anatomy and physiology.[76] Denley said he plans to hold a second grant competition this year. In Idaho, Boisen and Trigsted have a pending proposal that would provide funds for other departments interested in the redesign process to launch their own course transformations.[77]

Institutions with multiple campuses or large integrated systems can also benefit from using mini NCATs to streamline and more efficiently combine courses. In 2004, Penn State launched its Blended Learning Initiative, a program to redesign 30 courses so that they combine elements of traditional and active online student learning. Rather than just singling out high-enrollment and low-achievement courses for redesign, the initiative also tries to improve efficiency among small courses by using online options to combine courses with low enrollments that are offered at several of its more than 20 undergraduate campuses.[78] Some courses are moved fully online through a separate initiative called the E-Learning@ PSU Cooperative, which allows students at multiple campuses to all be placed in the same class section—eliminating duplication and increasing available offerings. By June 2009, the Blended Learning Initiative had redesigned 20 courses in subjects such as accounting, history, nutrition, philosophy, and Spanish.[79]

3) Increase Capacity

By all accounts, Polya has been a success for the University of Idaho—substantially reducing costs and even allowing the math department to withstand a quarter of a million dollar budget cut without any detrimental effects on student learning. Despite this, only two math courses are taught exclusively in the center, with a few calculus classes using the space for tutoring. But adding another course would exceed the facility's capacity. This became clear while observing a day of operation at the center in October 2009. As Trigsted talked about the center, he kept one eye constantly on the lab's real-time headcount, knowing that eventually he would have to open an extra tutoring room to provide more computers for students and space for them to use their own laptops.

Virginia Tech's Emporium has similar crowding issues, though it is bigger and has expanded to include seven courses entirely and parts of four others, says Michael Williams. Adding capacity to these facilities would help them take on additional redesigns, including potentially those from other departments. While adding capacity is an up-front expense, it pays for itself in cost savings down the road.

4) Change Faculty and Departmental Incentives

Faculty and departments control the educational process and are thus in the best position to adopt productivity-enhancing reforms. But there are few incentives for them to do so. University budget structures create few financial incentives at either the faculty or departmental level to save the university money. And college professors can expect little in the way of enhanced professional status or other career rewards if they find a way to substantially improve their students' learning or their ability to progress through college. Higher learning will remain decentralized for the foreseeable future, and for good reason. Given that, only a marked shift in

Table 2. Sample Learning Gains*

School	Course	Learning Gains
University of Idaho	Mathematics	The number of students who withdraw or fail from the course dropped by 20 percent.
Ohio State University	Statistics	Students averaged 8 percentage points higher on a common final exam than peers who took the same course in a traditional format.
Carnegie Mellon University	Statistics	Students in the transformed course correctly answered questions testing statistical concepts at a rate 30 percentage points higher than those in the traditional offering.
Virginia Tech	Linear Algebra	Students showed either modest learning gains or similar levels of achievement relative to their peers enrolled in traditional classes.
Tallahassee Community College	College Composition	Essays from the redesigned course improved relative to those from traditional sections when both were scored using a long-standing rubric developed by the state of Florida to measure college-level writing skills.
Fairfield University	General Biology	Knowledge retention improved, as measured by questions given to students in the required second-year course for biology majors that tested concepts covered in both the redesigned and traditional class.
Florida Gulf Coast University	Understanding Visual and Performing Arts	Seventy-seven percent of students in the redesigned course earned a grade of B or higher on course exams compared with just 37 percent of students in the traditional course.
Austin Peay State University	Developmental Studies	The percentage of students who brought their math skills up to college level increased from 53.3 percent to 73 percent. The number of students who completed a required for-credit math course went from 30.2 percent to 67.3 percent. The percent completing a required for-credit English course rose from 54.4 percent to 75.5 percent.

***Note:** Many redesigns did not continue to calculate student learning outcomes long-term, especially those that involved more than passage rates or grades. Thus, the data presented here are frequently from the first few years of a project.

incentives and priorities will create the conditions for wide numbers of faculty and departments to not just accede to innovation but actively seek it out.

Spreading Redesigns Across Institutions

1) Build a Corp of Experts

The experience of individuals who have gone through the redesign process and know what to expect is invaluable. They can share what they have learned with colleagues at other institutions and can cite their own work as proof the process is effective. While some level of skepticism will exist until the first redesign results come through, these knowledgeable faculty and administrators may be more convincing to their peers than a third-party organization. NCAT recognizes the advantages of harnessing this knowledge and has tried to better match experienced redesign leaders with those new to the process. Creating a community of experienced individuals also allows them to share ideas and support one another.

Developing redesign experts can create a "cross-pollination effect," which stands as one of the most successful methods of transferring knowledge and expertise among institutions. Several experienced redesign personnel have started their own projects when transferring to a new institution. The University of Idaho hired Boisen away from Virginia Tech to help start Polya and serve as its department math chair. Robert Olin left Virginia Tech to become the dean of the College of Arts and Sciences at Alabama, where he has since worked on that school's Emporium in addition to leading several other redesigns. Similarly, Denley began leading his redesign project at Austin Peay after previously working on a redesign at the University of Mississippi.

2) Work Across Disciplines

Communication within higher education is often more likely to happen between people in the same discipline in different institutions than between people in different disciplines within the same institution. Faculty who teach similar courses already come together through annual conferences, membership in trade associations, and by reading the same academic journals. Idaho decided to create its Polya math center after hearing about the experiences of an institution located more than 2,500 miles away.

Tapping into existing communication channels within academic disciplines could help increase the number of redesign participants. Even though they may be on different sides of the continent, professors teaching similar classes are likely to have common material, as well as common problems about how best to convey certain concepts.

3) Sell Success in Problem Areas

Developmental, or remedial, courses are widely disliked in higher education. Instructors don't like them because they have to teach material that should have been covered in the elementary and secondary education system. Students do not like them because they are often a costly roadblock for success that grants them no credit toward a degree. They are a concern for institutions because developmental students tend to have low graduation and retention rates. This is not a small problem—an estimated 42 percent of students at public two-year institutions and 28 percent of all students nationally take a remedial class.[80]

The general dislike of remedial classes presents an opportunity for innovators to expand their work. While an institution may resist efforts to change their for-credit offerings, they are less likely to do so for classes that are viewed as major problem areas. Selling the redesign process as especially promising for remedial classes could help overcome initial skepticism toward course transformation. Both Idaho and Alabama have also expanded their Emporium-based math redesigns to the high school level, which can help better prepare students so they can avoid remediation altogether.

4) Spread Redesigned Courses, Not Just Ideas

While faculty at larger institutions may have the time and resources to implement a redesigned course, instructors at smaller or more rural schools often do not have those options. In such cases, redesign may be more easily spread by allowing a school to offer a course that has been completely designed and created elsewhere. One such option for this form of redesign is Carnegie Mellon University's Open Learning Initiative, which offers 12 fully online courses in areas such as statistics, biology, logic and proofs, physics, and others. These classes are available for free to institutions and require only a modest maintenance charge to students.[81] Materials stay centralized at Carnegie Mellon, which constantly reviews student data to improve the course. The initiative was built as an expansion of its NCAT-supported statistical tutoring software and uses much of the same material used in Carnegie Mellon courses. According to Joel Smith, the vice provost, chief information officer, and co-principal investigator for the initiative, around 300 institutions have taken advantage of at least one of the 12 available courses.[82]

An alternative path for sharing course materials is through education publishers, many of which have partnerships with the center. Companies such as Pearson and McGraw-Hill are members of the Redesign Alliance, sponsor parts of NCAT's annual conference, and participate in that event's exhibition hall where they can showcase their products. These companies develop and distribute the materials that are often crucial for the computer-based portions of a course redesign. For example, 35 other colleges and universities in 20 states are currently using materials Trigsted developed for Polya that are now distributed by Pearson.[83] The relationships between NCAT, universities, and education publishers are essentially ones of mutual benefits. The center knows how to go through a redesign, but does not actually provide any of the materials. Universities want to transform a course but may lack the resources or desire to create their own computer-based text and problems. Publishers, meanwhile, benefit from having more opportunities to sell their products. Though just adopting an online textbook or incorporating administrative software that allows for

posting electronic lecture notes does not constitute a redesign, these types of software are crucial components. Sharing them across campuses may thus ease the burden of starting a new redesign.

Moving From Exception to the Norm

Whether it's posting lecture notes online, using an electronic discussion board, or offering a fully online class, it is nearly impossible to find a college course today that does not make some use of the Internet or related technology. For example, homework in introductory physics courses at Virginia Tech is completed and electronically graded online—a more efficient and cheaper solution chosen by the department after budget cuts reduced the number of available teaching assistants.[84] And though it still offers traditional lectures that meet multiple times a week, physics is toying with offering the lecture component of lower-level courses online for students who are not on campus during the summer or cannot fit the class into their schedule during the year.

But considering this use of technology as equivalent to a redesign is mistaking NCAT's methods for its ends. Virginia Tech physics courses are going online in the summer in the hopes of capturing tuition revenue from students who would have previously paid to take the class at other institutions.[85] Likewise, for-profit universities offer online classes both to teach the largest number of students at the lowest cost and to make courses fit into busy schedules. If NCAT's mission was just about getting colleges to apply technology cosmetically, then its work would have concluded long ago.

Instead, what makes the center's work revolutionary is the way it uses increasingly common means to achieve a set of goals that is often forgotten in today's higher education system: reducing costs while simultaneously improving student learning outcomes. Achieving these results requires a complete understanding of courses and a sense of how altering the various components—lectures, homework, etc.—can best lead to these outcomes. Course transformation is not easy. Success necessitates the buy-in of faculty, administrators, institutional support, and a willingness to try something new and different. Until colleges are willing to make tougher choices about the way their courses are structured and taught—choices that emphasize both student learning and cost savings, not either-or—then the need for innovators such as Carol Twigg and NCAT will endure.

The fact that colleges and universities have, to date, been unwilling to take on these tough challenges en masse has broad implications about the state of higher education that go beyond just the work of NCAT. Failing to adapt to changing financial conditions, tackle the ever-increasing costs of college, or improve stagnant graduation rates, increases the risk that America's higher education system will fall from its dominant position in the world. Fortunately, these are not intractable problems—innovators such as Twigg and NCAT have come up with cost-effective solutions that work. There are clear paths to reform. But NCAT and others cannot do all the work on their own. Without a greater push from federal and state policymakers and more openness to change from colleges and universities, higher education innovation will continue to be the exception, rather than the norm.

Appendix: Percentage Cost Savings of NCAT-Supported Course Redesigns, by Project*

Institution	Course	Traditional	Redesign	Per Student Savings	Aggregate Savings	% Savings	Enrollment
Program in Course Redesign, Round 1, 1999–2001							
Virginia Tech	Math	$91	$21	$70	$140,000	77%	2,000
University at Buffalo	Computer Literacy	$248	$143	$105	$63,000	42%	600
Penn State University	Statistics	$176	$98	$78	$190,320	44%	2,440
University of Illinois-UC	Statistics	$237	$165	$72	$230,400	30%	3,200
Program in Course Redesign, Round 2, 2000–2002							
University of Tennessee	Spanish	$109	$28	$81	$166,212	74%	2,052
Riverside Community College	Elementary Algebra	$206	$121	$85	$306,000	41%	3,600
University of Dayton	Psychology	$139	$84	$55	$46,750	40%	850
University of Massachusetts	Biology	$199	$124	$75	$52,500	38%	700
University of Iowa	Chemistry	$286	$191	$95	$130,150	33%	1,370
University of Alabama	Intermediate Algebra	$122	$82	$40	$60,000	33%	1,500
Fairfield University	Biology	$506	$350	$156	$43,680	31%	280
University of Idaho	Math	$139	$97	$42	$101,976	30%	2,428
Carnegie Mellon University	Statistics	$227	$171	$56	$23,520	25%	420
Program in Course Redesign, Round 3, 2001–2003							
Univ. of S. Mississippi	World Literature	$70	$31	$39	$78,000	56%	2,000
Univ. of New Mexico	Psychology	$72	$37	$35	$78,750	49%	2,250
Florida Gulf Coast Univ.	Fine Arts	$132	$70	$62	$74,400	47%	1,200
Drexel University	Computer Programming	$172	$97	$75	$31,050	44%	414
Tallahassee CC	English Composition	$252	$145	$107	$321,000	42%	3,000
Portland State University	Spanish	$127	$88	$39	$49,764	31%	1,276
Ohio State University	Statistics	$190	$142	$48	$127,200	25%	2,650
Brigham Young University	English Composition	$205	$175	$30	$88,500	15%	2,950
Roadmap to Redesign, 2003–2006							
Chattanooga St. Tech CC	Psychology	$130	$42	$88	$105,600	68%	1,200
Eastern Washington Univ.	Psychology	$100	$53	$47	$51,700	47%	1,100
Wayne State University	Precalculus	$185	$105	$80	$159,812	43%	1,994
Louisiana State University	Precalculus	$121	$78	$43	$210,700	36%	4,900
UNC-Greensboro	Precalculus	$109	$71	$38	$63,840	35%	1,680

Institution	Course	Traditional	Redesign	Per Student Savings	Aggregate Savings	% Savings	Enrollment
Roadmap to Redesign, 2003–2006, continued							
UNC-Greensboro	Statistics	$102	$68	$34	$27,200	33%	800
Univ. of Missouri-St. Louis	Precalculus	$170	$119	$51	$42,024	30%	824
University of Alabama	Spanish	$245	$183	$62	$86,490	25%	1,395
UNC-Chapel Hill	Precalculus	$153	$124	$29	$16,530	19%	570
Georgia State University	Precalculus	$96	$80	$16	$15,776	17%	986
Calhoun Community College	Statistics	$170	$144	$26	$10,166	15%	391
Texas Tech University	Spanish	$326	$283	$43	$79,980	13%	1,860
Maryland Course Redesign Initiative, 2006–2009							
Univ. of Maryland Eastern Shore	Chemistry	$268	$80	$188		70%	
Frostburg State University	Psychology	$89	$26	$63		71%	
Salisbury University[1]	Biology	$269	$52	$217		81%	
Arizona Board of Regents: Learner-Centered Education Course Redesign Initiative, 2006–2009							
University of Arizona	Chemistry	$199	$174	$25	$100,000	13%	4,000
University of Arizona	Biology	$266	$178	$88	$152,240	33%	1,730
University of Arizona	Geology	$437	$185	$252	$302,400	58%	1,200
Arizona State University	Chemistry	$439	$351	$88	$408,320	20%	4,640
Arizona State University	Women in Society	$78	$57	$21	$58,800	27%	2,800
Arizona State University	Geology	$92	$59	$33	$72,600	36%	2,200
Arizona State University	Computer Literacy	$50	$28	$22	$48,312	44%	2,196
Arizona State University	Public Speaking	$342	$142	$200	$120,000	58%	600
Arizona State University	Org. Management and Leadership	$373	$154	$219	$78,840	59%	360
Northern Arizona University	Psychology	$60	$42	$18	$36,000	30%	2,000
Tennessee Board of Regents: Developmental Studies Redesign, 2006–2009							
Austin Peay State University	Developmental Algebra	$448	$215	$233	$209,700	52%	900
Northeast State Community College	Developmental Reading	$197	$97	$100	$40,000	51%	400
Jackson State Community College	Developmental Algebra	$177	$141	$36	$66,204	20%	1,839
Cleveland State Community College	Developmental Algebra	$226	$183	$43	$51,600	19%	1,200

***Note:** NCAT only tracked cost savings for a year or two after project implementation, so figures present the initial annual savings projected by schools.

1. Final figure could be revised in the future.

Source: National Center for Academic Transformation, University System of Maryland.

Notes

1. Monte Boisen, chair, department of mathematics, University of Idaho, e-mail message to the author, Feb. 22, 2010.
2. Ibid.
3. National Center for Academic Transformation, "Program in Course Redesign: Round III Projected and Actual Savings Summary," http://www.thencat.org/PCR/R3Savings.html (Feb. 8, 2010); National Center for Academic Transformation, "The Ohio State University: Impact on Students," http://www.thencat.org/PCR/R3/OSU/OSU_FR1.htm (Feb. 8, 2010).
4. National Center for Academic Transformation, "Program in Course Redesign: Round I Projected and Actual Savings Summary," http://www.thencat.org/PCR/R1Savings.html (Feb. 8, 2010); National Center for Academic Transformation, "Virginia Tech: Impact on Students," http://www.thencat.org/PCR/R1/VT/VT_FR1.htm (Feb. 8, 2010).
5. National Center for Academic Transformation, "Program in Course Redesign: Round II Projected and Actual Savings Summary," http://www.thencat.org/PCR/R2Savings.html (Feb. 8, 2010).
6. National Center for Academic Transformation, "Carnegie Mellon University: Impact on Students," http://www.thencat.org/PCR/R2/CMU/CMU_FR1.htm (Feb. 8, 2010).
7. National Center for Academic Transformation, "Round II Projected and Actual Cost Savings."
8. Author calculated statistic by looking at institutions listed on the National Center for Academic Transformation's website.
9. Virginia Smith and Joni Finney, "Increasing Learning, Lowering Costs: An Interview with Carol A. Twigg," *Change Magazine,* May-June 2007, http://www.changemag.org/Archives/Back%20Issues/May-June%202007/full-increasing-lowering.html (Feb. 8, 2010).
10. Carol Twigg, "Navigating the Transition," *Educom Review,* Nov./Dec. 1994 http://net.educause.edu/apps/er/review/reviewArticles/29620.html (Feb. 8, 2010).
11. Carol Twigg, "Improving Productivity in Higher Education—the Need for a Paradigm Shift," *CAUSE/EFFECT,* Summer 1992, http://net.educause.edu/ir/library/text/cem9227.txt (Feb. 8, 2010).
12. Carol Twigg, in discussion with author, Aug. 17, 2009.
13. For example, a 1998 article in the *American Journal of Physics* by Richard Hake measured the results for 6,000 introductory physics students and found that those taught in traditional lectures tended to master less than 30 percent of material they did not already know before the start of the course. To read more, see Richard Hake, "Interactive-engagement vs. traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses," *American Journal of Physics,* Vol. 66, Issue 1 (January 1998): 64–74, http://www.physics.indiana.edu/~sdi/ajpv3i.pdf. For a review of much of the existing research on lecture-based instruction, see Joe Cueso, "The Empirical Case Against Large Class Size: Adverse Effects on the Teaching, Learning, and Retention of First-Year Students," *Journal of Faculty Development,* Vol. 21, Issue 1 (January 2007): 5-21, https://wiki.doit.wisc.edu/confluence/download/attachments/20938768/Cuseo.pdf.
14. *The Condition of Education 2004: Indicator 30: Top 30 Postsecondary Courses* (Washington, D.C.: National Center for Education Statistics, 2004) http://nces.ed.gov/programs/coe/2004/pdf/30_2004.pdf 167.
15. Michael Williams, associate professor of math, Virginia Tech, in discussion with the author, Sept. 29, 2009; Kay Mills, "Math Emporium," *National CrossTalk,* Winter 2005, http://www.highereducation.org/crosstalk/ct0105/news0105-virginia.shtml.
16. "Welcome to the Virginia Tech Math Emporium," Virginia Tech, http://www.emporium.vt.edu/ (Feb. 22, 2010).
17. The cost savings reflect lessened instructor, graduate assistant, and faculty time spent preparing, designing materials, and delivering lectures. The capital costs of the Math Emporium are not factored in because it is used by multiple classes. National Center for Academic Transformation, "Virginia Tech: Impact on Cost Savings," http://www.thencat.org/PCR/R1/VT/VT_FR2.htm (Feb. 8, 2010).
18. National Center for Academic Transformation, "Virginia Tech: Impact on Students."
19. Sally Search, dean for academic support programs, Tallahassee Community College, in discussion with the author, Sept. 14, 2009; Success as defined by Tallahassee Community College means earning a C or higher.
20. National Center for Academic Transformation, "Program in Course Redesign: Round III Projected and Actual Savings Summary."
21. National Center for Academic Transformation, "Tallahassee Community College: Impact on Students," http://www.thencat.org/PCR/R3/TCC/TCC_FR1.htm (Feb. 9, 2010); Florida Department of Education, "College-Level Academic Skills Test," http://www.fldoe.org/asp/clast/ (Feb. 9, 2010).
22. Shelley Phelan, in discussion with the author, Feb. 23, 2010.
23. National Center for Academic Transformation, "Program in Course Redesign: Round II Projected and Actual Savings Summary," http://www.thencat.org/PCR/R2Savings.html (April 29, 2010).
24. National Center for Academic Transformation, "Fairfield University: Impact on Students," http://www.thencat.org/PCR/R2/FU/FU_FR1.htm (Feb. 9, 2010).
25. A. James Wohlpart (comments at the conference "Is Technology the Answer to Rising College Costs?" Education Sector, Washington, D.C., December 2008) http://www.educationsector.org/events/events_show.htm?doc_id=717088 (Feb. 9, 2010).
26. National Center for Academic Transformation, "Florida Gulf Coast University: Impact on Cost Savings," http://www.thencat.org/PCR/R3/FGCU/FGCU_FR2.htm (April 29, 2010).
27. Scott Kaakas, Elizabeth Heath, and Lisa Courcier, "Lessons from the Ether," p. 202.
28. A. James Wohlpart, Craig Rademacher, Scott Karakas, Lisa Courcier, and Charles Lindsey, "Online Education in the Visual and Performing Arts: Strategies for Increasing Learning and

Reducing Costs," *Journal of Educators Online* 3, no.1 (Jan. 2006): 12.

29. National Center for Academic Transformation, "Ohio State University: Improving the Quality of Student Learning," http://www.thencat.org/PCR/R3/OSU/OSU_PR1.htm (Feb. 9, 2010).

30. Jeffrey Young, "'Hybrid' Teaching Seeks to End the Divide Between Traditional and Online Instruction," *Chronicle of Higher Education,* March 22, 2002, http://chronicle.com/article/Hybrid-Teaching-Seeks-to-End/18487/ (Feb. 9, 2010).

31. National Center for Academic Transformation, "Ohio State University: Impact on Students," http://www.thencat.org/PCR/R3/OSU/OSU_FR1.htm (Feb. 9, 2010).

32. National Center for Academic Transformation, "Ohio State University: Impact on Students."

33. National Center for Academic Transformation, "Program in Course Redesign: Round III Projected and Actual Savings Summary."

34. National Center for Academic Transformation, "Program in Course Redesign: Round I Projected and Actual Savings Summary"; National Center for Academic Transformation, "Program in Course Redesign: Round II Projected and Actual Savings Summary"; National Center for Academic Transformation, "Program in Course Redesign: Round III Projected and Actual Savings Summary." Grant recipients in the first round were allowed to redesign a single section without having to redesign the whole course. As a result, six of the 10 initial recipients did not do a full-course redesign. The other 20 grant recipients had to redesign the whole course as part of their award. Among these institutions, only three failed to implement a full redesign.

35. Author calculated statistic by looking at cost savings information on the National Center for Academic Transformation's website.

36. The actual performance metric varied by institution, but usually relied on student passage rates, grade distribution, retention rates, or concept understanding. Many redesigns used exams and assignments given to both traditional and redesign sections or diagnostic tests administered at the start and end of a course to ensure that students were not doing better because the course had become easier. Portland State University did register some learning gains, but they were not statistically significant. The University of Illinois at Urbana-Champaign did not report learning information on the NCAT website.

37. Fund for the Improvement of Postsecondary Education, "Rensselaer Polytechnic Institute: Establishing National Academic Practices to Leverage Key IT-Based Innovations," U.S. Department of Education, Sept. 1, 2003, http://www.fipse.aed.org/grantshow.cfm?grantNumber=P116B030435 (April 29, 2010).

38. Peter Ewell, "External Evaluation of the FIPSE Roadmap to Redesign (R2R) Project Grantee: P116B030435 Rensselaer Polytechnic Institute 2004–2006 Final Report," (Boulder, CO.: National Center for Higher Education Management Systems) 17.

39. Ibid. The redesign of college algebra at Louisiana State University did report much lower retention rates, though this was not statistically significant due to problems on the campus stemming from the aftermath of Hurricane Katrina and changes in the class that allowed more students to place out of it based upon test scores.

40. Ibid., 6, 14.

41. Ibid., 14.

42. National Center for Academic Transformation, "Redesign Scholars Program: Position Description," http://www.thencat.org/RedesignAlliance/RSPPositionDesc.htm (Feb. 9, 2010).

43. National Center for Academic Transformation, "Colleagues Committed to Redesign (C2R): Round I Redesign Projects," http://www.thencat.org/RedesignAlliance/C2R/Rd1ProjDesc.htm (Feb. 9, 2010); National Center for Academic Transformation, "Colleagues Committed to Redesign (C2R): Round II Redesign Projects," http://www.thencat.org/RedesignAlliance/C2R/Rd2ProjDesc.htm (Feb. 9, 2010); National Center for Academic Transformation, "Colleagues Committed to Redesign (C2R): Round III Redesign Projects," http://www.thencat.org/RedesignAlliance/C2R/Rd3ProjDesc.htm (Feb. 9, 2010). Participants were not required to redesign the whole course, which helps to explain the low total number of fully implemented redesigns.

44. Tennessee Department of State, *Tennessee Blue Book: Higher Education,* March 2008, http://www.state.tn.us/sos/bluebook/07-08/15-TBR.pdf 175.

45. Paula Myrick Short and Treva Berryman, "Shifting Developmental Studies into High Gear: A System Approach to Redesign in Tennessee," (PowerPoint presentation at the 2009 National Forum on Education Policy, Nashville, Tenn., July 2009) http://www.ecs.org/html/meetingsEvents/NF2009/resources/ShiftingDevelopmentalStudies%20.pps slide 4.

46. Paula Myrick Short and Treva Berryman, "Shifting Developmental Studies into High Gear: A System Approach to Redesign in Tennessee" slide 3. Treva Berryman, in discussion with the author, Aug. 24, 2009.

47. Fund for the Improvement of Postsecondary Education, "Tennessee Board of Regents: Academic Preparation Initiative," U.S. Department of Education, http://www.fipse.aed.org/grantshow.cfm?grantNumber=P116B060289 (Feb. 9, 2010).

48. Treva Berryman, in discussion with the author, Aug. 24, 2009.

49. Paula Myrick Short, the vice chancellor for academic affairs at TBR, is in charge of the redesign project at the board of regents.

50. Austin Peay's redesign was modeled off a program first introduced at Ferris State University in Big Rapids, Mich., in 1993. For more about the program at Ferris State, see Ferris State University, "Structured Learning Assistance: Our Program," http://www.ferris.edu/sla/PI_Our_Program.htm (Feb. 9, 2010).

51. Nell Rayburn, in discussion with the author, Oct. 15, 2009.

52. Kimberly Noble, in discussion with the author, Oct. 15, 2009.

53. Martin Golson, instructional specialist, Austin Peay State University, in discussion with the author, Oct. 15, 2009.

54. Ibid.

55. Ibid.

56. "Structured Learning Assistance," PowerPoint presentation, Austin Peay State University, p. 5

57. Ibid.

58. Martin Golson, in discussion with the author, Oct. 15, 2009. The institution did not collect cost data for the English project.

59. National Center for Academic Transformation, "Report to the Arizona Board of Regents (ABOR) on the Learner-Centered Education Course Redesign Initiative," (June 2009), http://www.abor.asu.edu/4_special_programs/lce/ABOR-NCAT%20Final%20Report%202006-2009.pdf 30.

60. National Center for Academic Transformation, "Report to the Arizona Board of Regents (ABOR) on the Learner-Centered Education Course Redesign Initiative," 14.

61. Maryn Boess, in discussion with the author, Oct. 27, 2009. Arizona State is replicating the supplemental model it used in a general chemistry redesign to redo its college algebra course. Northern Arizona is establishing a mini-grant program of its own and disseminating lessons learned to faculty. Arizona is creating a website to warehouse all course redesign information and serve as the central redesign community for all three universities.

62. Robert Sanders, in discussion with the author, Sept. 17, 2009.

63. A. James Wohlpart, associate dean, College of Arts and Science, Florida Gulf Coast University, e-mail message to author, Aug. 13, 2009.

64. Of the 10 original programs contacted by the author, none of them still monitored costs in a substantive way.

65. The Secretary of Education's Commission on the Future of Education, *A Test of Leadership: Charting the Future of U.S. Higher Education,* (Washington, D.C.: U.S. Department of Education, Sept. 2006) p. 21, http://ed.gov/about/bdscomm/list/hiedfuture/reports/final-report.pdf.

66. The Bill and Melinda Gates Foundation provides funding to Education Sector. It did not fund the production of this report.

67. National Center for Academic Transformation, "Changing the Equation: Redesigning Developmental Math: Application Guidelines," http://www.thencat.org/Mathematics/CTE/CTEAppGuide.htm (Feb. 10, 2010).

68. Michael Williams, in discussion with the author, Sept. 29, 2009.

69. Harriet McQueen, in discussion with the author, Oct. 15, 2009. The ruling from TBR meant that any student requiring developmental education would have to go to a nearby community college. Austin Peay, however, was given special dispensation because it is not located near a Tennessee community college. The terms of this exception, however, stated that the school could not charge more than community college tuition for these courses—an expensive proposition because it still had to pay instructors university-level salaries.

70. Monte Boisen, in discussion with the author, Oct. 14, 2009.

71. Joe Benson, senior associate dean of the College of Arts and Sciences, University of Alabama, in discussion with the author, Aug. 28, 2009.

72. Monte Boisen, in discussion with the author, Oct. 14, 2009.

73. Morgan Paine, associate professor of art, Florida Gulf Coast University, in discussion with the author, Aug. 24, 2009.

74. Ibid.

75. Pennsylvania State University Testing Center, "Testing Center Use, Fall 2008, by week, day, and hour," http://testing.psu.edu/pdf/F08_TC_Use_Statistics.pdf (Feb. 11, 2010) 1.

76. Tristan Denley, in discussion with the author, Oct. 16, 2009.

77. Monte Boisen, "Improving the Quality of Instruction While Significantly Lowering Costs—Teaching in the 21st Century," Request for Innovation, University of Idaho, March 13, 2009, http://bit.ly/dlGAHB (Feb. 10, 2010).

78. "Overview of eLearning@PSU Cooperative," Pennsylvania State University, June 2009, 3.

79. Ibid., 4.

80. National Center for Education Statistics, "Table 31-1. Number of entering freshmen at degree-granting institutions, and percentage of entering freshmen enrolled in remedial courses, by subject area and type of institution: Fall 1995 and 2000," U.S. Department of 'Education, http://nces.ed.gov/programs/coe/2004/section5/table.asp?tableID=83 (Feb. 11, 2010).

81. Open Learning Initiative, "Frequently Asked Questions," Carnegie Mellon University, http://oli.web.cmu.edu/openlearning/initiative/faqs#academicCredit (Feb. 11, 2010).

82. Joel Smith, in discussion with the author, Aug. 21, 2009.

83. Obtained from a list of schools provided by Katherine Greig, the senior marketing manager for precalculus at Pearson Higher Education.

84. Beatte Schittmann, professor and chair of the department of physics, Virginia Tech, in discussion with the author, March 2, 2010.

85. Ibid.