

Technological Transformation

An ambitious national effort to use technology more effectively in large introductory university classes

Photos by Axel Koester for CrossTalk

By Kay Mills

POMONA, CALIFORNIA

THIS IS NOT your father's introductory psychology course. No professor is standing in front of a vast lecture hall, writing concepts like "operant conditioning" or "depression" on the blackboard. No students are nodding off, at least not that anyone can see. They're all sitting at computers, either at home, in their dormitory, or in an on-campus lab.

For the redesigned Psychology 201 class at Cal Poly Pomona, there is a website, a password, lectures streamed online, a CD-ROM for drilling tricky material, a chat room for discussions, e-mail for asking questions, and assignments and exams online. During the last spring quarter, this California State University campus, about 30 miles east of downtown Los Angeles, had one professor teaching the introductory general psychology course online while four others taught in the more traditional lecture method. This fall two professors will conduct large online sections, and next winter quarter students will only be able to take the class online.

Cal Poly Pomona is part of an ambitious national effort to use technology more effectively in large introductory university classes, to improve instruction in what are often deadly dull lecture classes with high dropout rates, and to save money as well.

This redesign project is run by the Center for Academic Transformation, headquartered at Rensselaer Polytechnic Institute in Troy, New York. Its goals may sound like an oxymoron but they're not, according to Carol Twigg, the center's executive director and the moving force behind the project. "Most people in higher education think you improve quality by spending more money," Twigg said. But that's not necessarily the case, she argues, and she clearly thinks this program is proving it.

Supported by an \$8.8 million grant from the Pew Charitable Trusts, Twigg is encouraging academics to think differently about how they use technology. If they just use it to duplicate what they do in lecture halls, she says, they will not save money or teach much more effectively. As part of the Pew Learning and Technology Program, Twigg's center has provided \$200,000 grants to 30 colleges and universities across the country to redesign large classes. The project tests the premises that economies of scale could help the schools save money, and that better use of technology could help students focus better on what they are supposed to learn.

The schools range in size from Fairfield University, a private school in Connecticut with an enrollment of 5,200, to large public campuses like the University of Wisconsin-Madison, the University of Central Florida, and Penn State. Three community colleges also are included.

The redesigned introductory courses include algebra, computer literacy, computer programming, English



Karen Brzoska (right), an instructional technology designer, created a CD-ROM that is a key part of a restructured introductory psychology course at Cal Poly Pomona.

composition, fine arts, Spanish, astronomy, sociology, American government, psychology, statistics, biology, world literature and chemistry.

Each institution has redesigned one course. But Twigg is convinced that if colleges learn the methodology, they will not need a grant to move on to redesigning other classes—they'll generate their own savings. The goal, she said, "is to move beyond 30 models to change the way every introductory course in the country is taught." If all institutions were to redesign their top 25 courses using the center's methods, she projects an overall reduction in the cost of higher education of about 17 percent. She acknowledges that's "a pretty large goal."

While individual universities or faculty members have redesigned courses using technology in the past, there has been nothing like this project in any coordinated fashion, said Peter Ewell, senior associate at the National Center for Higher Education Management Systems in Boulder, Colorado. In most earlier redesign efforts, instruction has remained teacher-centered rather than learner-centered, he said. With this systematic approach, "you have to fundamentally

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The goal of “academic transformation” is to “change the way every introductory course in the country is taught,” says Carol Twigg, the moving force behind the national project.

rethink what’s going on.” Ewell thinks that is revolutionary.

Writing the grant proposals was part of the rethinking process. Universities interested in the program responded to eight “readiness criteria”—for example, did support for redesigning a course extend to the schools’ top levels? Did they have the infrastructure and experience to undertake such a project?

About 150 universities participated in this process for each round; the number was then reduced to 40. Those that made that cut, and another down to 20, attended workshops at which Twigg went over the redesign process. “We started with the premise that institutions

don’t know how to do this. We have to teach them to think differently,” she said. The center provided applicants with what Twigg called “aggressive help” in preparing proposals. Rather than having potential grantees guess what the center wanted, the staff told them. That means the schools should be measuring their results with the same yardsticks.

People don’t always recognize the innovative potential of technology. For example, when the Pony Express faced the invention of the telegraph, it responded by buying faster horses, then trying to hire better riders, Twigg has written. Or when banks first used automated teller machines, they located them inside their branches, where they were available only during banking hours. Only when the ATMs were placed outside and in grocery stores or airports, available at all hours, did real innovation occur.

It is clear that Twigg also hopes schools will move beyond the idea that there is no significant difference in traditional and online courses and no significant learning difference. She believes that students learn more when they participate actively instead of passively listening to lectures or following online courses without significant interaction. Good instructional software “engages the full range of the human senses through multimedia technology,” she has written. “In short, good learningware encourages active learning.”

In assessing savings, the center does not include the cost of wiring campuses for computers. “You cannot be a college or university in the 21st century without being a networked campus,” Twigg said. That is going on all over, so schools involved do not include that in the calculation of redesign expense. If a school needs to buy some special software for the course, however, that does count in the cost.

“You reach the savings in terms of people’s time,” Twigg said. “You might have a situation in which seven people taught the introductory course and now it is handled by four. Those three people can be doing something else. Or if you use adjunct faculty or teaching assistants, you don’t need to hire as many.”

Jane Wellman, senior associate at the Institute for Higher Education Policy in Washington, D.C., cautions that “tracking the savings is key. If the savings aren’t documented—if they’re hypothetical or swallowed up by other programs—then they won’t ‘count’ in the way we account for costs in higher education. So documenting where real cash money is saved and how it’s being redirected or reprogrammed is important.”

The redesign grants started three years ago, and each grant lasts two years. Each school has faced its own challenges—convincing faculty to get involved, getting them accustomed to the technology, building enough structure into the courses so that students don’t easily fall behind, and dealing with staff departures or illnesses.

At Cal Poly Pomona, 1,800 students each year take Psychology 201 toward their general education requirement. Another 750 would like to take the course but cannot because of classroom space limitations. With California facing a \$23.6 billion budget deficit, there obviously will be less money rather than more. The school has been working to redesign this psychology course to accommodate more students.

Changing the course, taken mostly by non-psychology majors, was an evolutionary process. It started in 1995 when Sonia Blackman of the behavioral sciences department had a hip replacement and thus limited mobility. She taught this psychology course to 22 students in the on-campus television studio, broadcasting to two more rooms in which there were 70 to 100 students each.

An artist as well as a professor, Blackman found creative ways to present her topics using illustrations or demonstrations. She decided that if she could do that, the department might use its professors to put together a videotaped course. She convinced some of her colleagues to tape lectures on their specialties, using whatever props they wanted.

“This course came up the ideal way—it emerged from the faculty,” said Barbara J. Way, dean of the College of Letters, Arts and Social Sciences. “Sonia convinced some of the faculty it would be a good thing to do.”

Originally, students checked the video lessons out of the library. That had built-in restrictions, such as library hours and the number of copies of the videos available. Even though there were multiple copies, some students would keep them too long or everyone would want them the night before an exam. Now the videos are available online.

Blackman and Cal Poly Pomona applied for a redesign

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grant to develop a CD-ROM as a tutorial for the psychology course, to redo some of the videos, and to shift the course onto WebCT software. Blackman felt the CD was needed because “in any course there are several lessons that are very hard for students to grasp.” In general psychology, these include experimental design, classical conditioning, operant conditioning, and depression.

The CD, developed with instructional technology designer Karen Brzoska, begins when a student on a field trip finds a glass jar. He peers into it and a Tinker Bell-like character named Sigmundia beckons him along to help free inhabitants of a “dark world” held captive against their will. While in essence playing an educational video game, students drill on concepts they have been learning through the video lectures and textbook. Some faculty felt that students would not warm up to instruction online or through CDs, but “this generation has demonstrated how addictive computers are,” Blackman said.

Carol Twigg agreed. “The problem generally is not the students but some of the faculty,” she said. “Luckily, we’ve found some pioneering faculty who are willing to show the way.”

Cal Poly Pomona had hoped to implement the redesigned course fully last fall but illness forced Blackman to retire. The department patched together the instruction for that term. The person who filled in made some changes as she went along, and now, the college dean said, those changes have been incorporated.

Felicia Friendly Thomas, professor of behavioral sciences, took over the class during the winter term. She had to learn how to use WebCT, she said, and spent more time on the class than a traditional approach would have required. Now Thomas spends about the same amount of time as before. She doesn’t have to lecture because that material is on the video, but the balance of her time is spent monitoring the electronic bulletin boards and answering e-mail about the course content.

Course work is carefully mapped out. The website shows the syllabus, schedule, instructions, assignments, the textbook publisher’s related resources that are online, an area in which students can check their own progress, and the class bulletin board. Students have regular assignments that they can do at their own pace—up to a point—but once the deadline has passed, they can’t go back into that material.

“Computers crash,” Thomas acknowledged, “so there is one written assignment each that a student can miss.”

Exams are also taken online with Thomas monitoring the test periods. The computer randomly generates questions, and students see one question at a time. If they skip a question, the computer will not let them go back to it. “I tell them I put the most difficult questions at the end, usually those based on the video lessons. They’re not in the book. They don’t know what’s coming” so they can’t spend time in the early part of the test looking up answers. This is Thomas’s way of trying to “minimize academic dishonesty.”

Thomas had 186 students in her spring quarter online class. This fall, she and another professor will handle online sections of the class to accommodate a total of 400 students. Traditional sections will also be offered. But in the winter quarter, the class will be offered only online.

While administrators and faculty involved basically are supportive of the online approach, there is still some ambivalence. “If we could check these students ten years from now,” Thomas said, “I’d like to ask how much of [the course content] did they keep? Do they view it as a canned class that they took and got a good grade and moved on? Was there something about a face-to-face class that increased the probability that a student would take life lessons from it? I don’t know the answer to that question.

“If it is less personal, do you personalize less?”

Even though Cal Poly Pomona wants to put more Psychology 201 students online, Dean Way thinks that her college will have to continue offering some traditional sections. “Digitally delivered classes don’t work for everybody, so we have to identify the largest populations where it is good,” Way said. Those groups might include working people, young mothers with children at home, more mature students, she added.

Using the CD-ROM tutorials and computer-based testing should allow the university to reduce faculty hours significantly and replace them with less expensive teaching assistant hours. As a result, the university had said in the early days of the project, the cost-per-student would drop from \$152 to \$21, a reduction of 86 percent.

But Way says the school probably hasn’t saved any money yet. There are “incredible amounts of time invested up front.

An administrator like myself has to recognize that faculty can’t do this and maintain their workload, at least initially. You just burn them out.” In the development phase, she said she “tried to be generous to give faculty time to work on this. You can’t anticipate what will go wrong technologically. Once we’ve got that under control, one professor can take up to 200-250 students,” with teaching assistants to help supervise.

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At Riverside Community College, a math lab was established where students receive help from faculty or tutors and where they do their assignments online.

Some 3,600 students each year take elementary algebra, the lowest-level math class that fulfills the general education requirement. The traditional lecture format had minimal student interaction with faculty and didn't account for students' different learning styles and widely varied backgrounds.

Riverside cut the lecture time in half because, as Sheila Pisa, associate professor of math, explained, faculty members were spending 15 to 30 minutes of each class answering homework questions. The redesign project shifted those homework assignments to an interactive software program that generated individualized assessments, study plans and learning sets. A math lab was established where students receive help from faculty or tutors and where they do their assignments online.

One lesson learned from the redesign process, Pisa said, is to match the technology to the course. Once the pilot project was under way, the faculty discovered that the software didn't go along with the textbook. Students like to see the material presented in the same way, and so they were sometimes confused, Pisa explained. So this fall the course will use a different textbook and software called "My Math Lab" that comes with it.

Riverside calculated that it saved about \$140,000 in wages with the redesign—almost exactly the amount it cost to set up the math lab that the school had needed anyway. That lab will generate even more savings because students from other courses use it, too. The redesign process also prodded the faculty to agree on a level of standardization for this course, which Pisa said professors had been talking about for some time.

Other schools among the 30 pilot projects also report compelling results.

Rio Salado, part of the Maricopa Community College District headquartered in Tempe, Arizona, intended to

UPDATE
Online Instruction Proliferates on Campus
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THE EXPANSION of technology in higher education seems to be an unstoppable force. There is no avoiding it, even for those who see it as an encroachment on the purity of academia. In the summer of 2002, *National CrossTalk* examined an ambitious national program, run by the National Center for Academic Transformation (NCAT), to use computer technology in large introductory courses as a means of improving instruction and cutting costs. Since that time, interest in such approaches has only grown.

"We've expanded well beyond the initial 30 schools in the original process," said Carol Twigg, NCAT's executive director. "There are two additional national projects, with 20 schools in the first project, and 60 in the second."

The first of the two projects, called Roadmap to Redesign, lasted from 2003 to 2006, while the second, called Colleagues Committed to Redesign, began in January 2008. "We took the lessons learned from the original Pew-funded process and streamlined it so schools wouldn't have to reinvent the wheel," Twigg said.

NCAT is also putting major emphasis on developing state-funded programs that replicate the national process. "We have six state programs going on—in Arizona, Tennessee, Mississippi, Texas, Maryland, and SUNY in New York," Twigg said. "SUNY has 60 institutions, and they're going to award ten grants, similar to the national program, but in this case the state is providing the funding." That will ultimately result in 70 to 80 new redesigns by 2010.

"We are in discussion with other state systems to launch additional programs," Twigg said. "It's really exploding. We've gone from the original 30 schools to about 200, in one form or another."

The corporate world is getting involved as well, through the Redesign Alliance, a national association for colleges and companies. "The Corporate Associates Program involves companies that are members of

the alliance—mostly higher ed publishing and software companies whose materials are used in the redesigns," Twigg explained.

The corporate associates (of which there were five in the 2007-08 academic year) are paying an annual fee of \$50,000. Smaller companies can also participate in the alliance for \$5,000 per year. "Companies that pay the \$50,000 membership get more in return," Twigg said. "The smaller companies can't afford that, so we give them a chance to get involved."

The proliferation of programs such as these speaks to the desirability of what they promise. But do they really work as intended? Do they pay off?

Peter Ewell, vice president of the National Center for Higher Education Management Systems, has his doubts. "I still have my reservations about that," he said. "Carol Twigg is now in the third voluntary semi-funded project that involves individual institutions. Each successive round has been a little less successful than the last. The first 30 programs were spectacularly successful, but in the ensuing rounds, there has been a little less bonsai spirit." Ewell, who also serves on NCAT's board of directors, suggested that the declining success of the programs is "largely because institutional commitment is less because they're not receiving any money."

As to the savings generated by online courses, Ewell said that it is disingenuous to suggest that they are plowed back into academic programs. "The bottom line is fewer faculty," he said. "If there is no increase in what one might call efficiency in the instruction, there's no point in doing this. You can go in with a straight face and say you're going to grow enrollment and not have to get rid of anybody, but this will result in fewer full-time faculty per student. That clearly is the case."

Nevertheless, some faculty find this very exciting, and are anxious to embrace the new technology. "What you're seeing is a quiet revolution,

Are the savings generated by online courses really plowed back into academic programs, or do they merely allow colleges to hire fewer full-time faculty?

redesign the delivery of its introductory algebra course. It wanted one instructor to handle 100 students while devoting more time to content instead of troubleshooting technology problems and performing course clerical work.

But because Rio Salado begins each of its distance learning classes every two weeks, it proved too difficult to enroll 100 students in any one section. Instead, the college redesigned its course management system so that one instructor handled four different math courses with a total of 100 students.

The redesign added a course assistant to work on the technology questions, monitor student progress and alert the instructor when students were having difficulty with the material. The instructor could therefore spend more time on content.

Virginia Tech, in Blacksburg, Virginia, redesigned its linear algebra course, which is taken by about 2,000 first-year engineering, physical sciences and math students. The redesign was part of a larger transformation project for all large-enrollment math courses, made possible by the opening of the Math Emporium, a 500-workstation computer lab and

learning center.

Lecture sections for the redesigned course were eliminated and all the classwork is conducted in the Math Emporium, which is open every day. Content was organized into units that a student would normally cover at a rate of two a week, followed by a quiz. Interactive tutorials give the student feedback.

The Math Emporium employs student tutors, who point students toward appropriate resources for answering their questions. Last fall the shift in format allowed one professor to handle 1,500 students and helped the university save more than \$130,000, said math professor Ken Hannsgen.

“This is just a first shot,” Hannsgen said. “When you consider that traditional methods have had decades or even centuries to perfect themselves, I think we’ve made a good beginning. You should encourage people to be creative—maybe you can do more than you expect.” There were a lot of doubters, he added. “But you should not listen to the worst fears.”

A major lesson from the redesign process, said Carol

a generational shift,” Ewell explained. “Thirty-year-old faculty like the teacher technology. They’re good at it. They understand it.”

A case in point is Felicia Friendly Thomas, a professor of clinical psychology at Cal Poly Pomona who was featured in the 2002 article. At the time, Thomas had to master the new teaching technology in order to conduct a redesigned introductory psychology course, and has since become an advocate for online learning.

“I have done a number of research studies on learning in the online environment, and presented at numerous conventions over the course of the last four years in every imaginable topic of online learning and instruction,” Thomas said. In 2005, for instance, at the Western Psychological Association convention, Thomas gave a presentation entitled, “Can one teach about human behavior in a non-human environment?”

While Cal Poly was considered only “partially successful” in its redesign program, according a report by NCAT, and did not complete or fully implement its redesign plans, online instruction is more popular there than ever.

“At Cal Poly we have pre-registration, and this is one of the courses that closes almost immediately on the first day it is available,” Thomas said of her online introductory psychology course. “It’s extremely popular. I usually have twice as many students trying to get into the course as there are spaces.”

The use of online resources is popular in a growing number of non-introductory and upper-division courses as well, and Cal Poly has licensed an educational database program called Blackboard to help facilitate this. “All of our courses are automatically uploaded into Blackboard,” Thomas said. “An instructor can decide if he or she wants to use some, all or none of the

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features available within Blackboard. Even the regular, traditional courses have that available to them.”

Most of the resistance to online pedagogy comes, predictably, from faculty. “A few recalcitrant faculty can stop dead the process,” Twigg said. “Something that will typically happen in a research university is that the research-oriented faculty are resistant. One of the reasons we chose to focus on introductory courses was because there is less possessive ownership of introductory courses, and generally star faculty are not involved in them.” Peter Ewell was more blunt, referring to the courses as “mega-classes that nobody wants to teach anyway.”

The students, on the other hand, seem to be embracing the new technology. Thomas says that they are demanding online courses, and Twigg concurs. “Students like it,” she said. “They become big advocates of changing other courses. We have plenty of stories of students who failed in the traditional course, and then passed the redesigned course.”

A lot of the math programs, in particular, show impressive results, according to Twigg. “They make gains in scores initially, and then the sores continue to go up,” she said, citing the University of Alabama as an example. “In Alabama, prior to their original redesign, only 40 percent of students passed college algebra; after the redesign, in the first year in implementation, it was 60 percent. That number has increased steadily to 80 percent.”

Another much-touted success story is the Math Emporium at Virginia Tech, a facility with hundreds of computers, staffed by faculty and teaching assistants, where thousands of students satisfy introductory math requirements.

“I don’t think there is as much resistance to using educational technology as there was ten years ago—it’s how things get done,” said Jane Wellman, executive director of the Delta Cost Project, an organization that focuses on college affordability and institutional productivity. “When it is done comprehensively it clearly both saves money and produces better results.” She cautioned, however, that the technology has to be used in the right way. “Whether this is resulting from comprehensive, thoughtful redesign—whether it’s something other than just putting the Internet in the classroom—remains to be seen.”

—Todd Sallo



Felicia Friendly Thomas, professor of behavioral sciences, directs the psychology course redesign work at Cal Poly Pomona.

Twiggy, is that “the more you individualize the learning process for students, the better the results are. Virginia Tech is a good example of this. They have gone to the level of what each student is ready to learn and what problems each has” and have structured their course around that. “The more you do this, the more successful you will be.”

Math and other quantitative courses appear the most likely candidates for using technology to increase quality and decrease costs. But some schools are redesigning world literature, the performing arts, and English composition.

Brigham Young University is reducing the amount of time students spend in the classroom and replacing it with interactive multimedia lessons for its first-year writing course. The technology also helps the university standardize a course that has had a wide range of quality because of different experience levels within the faculty.

The University of Southern Mississippi is testing an online section of its world literature course in which faculty presentations of the content are taped and placed online along with instructors’ notes, additional media resources, quizzes,

exams and essay assignments. Students can attend the live presentations, but the school reports that only a handful do—sometimes none at all.

Change, reform, revolution—whatever one calls it—is never easy in any field. “Universities are going to push back a good deal more” when redesign efforts go beyond pilot

projects, said Peter Ewell of the National Center for Higher Education Management Systems. He sees three questions to be addressed:

- How far-reaching can redesign be? “It’s no coincidence that most of the redesign projects are in math and science,” Ewell said. “In those fields you have a faculty that can agree on the outcomes it wants.” It is harder to convince faculties in the humanities and social sciences to do this because “that means giving up ‘my god-given right to do what I want to do.’”
- How do you deal with credit hours and registration? How do you account for faculty teaching load? How do you alter, in Ewell’s words, the “administrivia” of academic life with these redesigns?
- What do you do with the savings? This is perhaps the most fundamental question. Right now, many schools are selling the redesign process to faculty who want to be freed to do their own research or teach upper-level courses. “But that’s just feeding the higher education habit,” Ewell said. If you implement these redesigns big-time, he asked, shouldn’t you be putting a lot of that money back into lower-division courses? And if you enlarge the redesign process, isn’t it likely that colleges and universities will need fewer core faculty in the future?

To spread the word about the redesign process, the Center for Academic Transformation encourages participating schools to disseminate their findings on their own campuses and at conferences. For example, Fairfield University, which redesigned its two-semester general biology course with a Pew grant, hosted a conference this summer. Conferees discussed what worked and what didn’t, how redesign results can be assessed, and how more faculty members can be brought on board. The center also maintains a website (www.center.rpi.edu) containing extensive detail about each college’s effort.

“I’ve been talking about these ideas for a long time,” Twigg said. “I think we’ve proved that you can do this. Now the question is how do you disseminate these ideas more rapidly through higher education so that people who hear about the process won’t start from scratch. We let these 30 schools experiment, within certain parameters. Now we know what works.” ♦

Kay Mills is the author of “This Little Light of Mine: The Life of Fannie Lou Hamer,” and four other books.

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—Carol Twigg, executive director of the Center for Academic Transformation