Colleges Cope With Bigger Classes

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BOULDER — On weekday mornings, the Cristol Chemistry Building at the University of Colorado is a hive of activity. Every hour, hundreds of laptop-toting students file in and out of its theater-style lecture halls, where classes are scheduled back to back.

Images (showing 1 of 7 photos)

Students use computers in the Virginia Tech Math Emporium in Blacksburg, Va., Thursday, April 5, 2007. (AP Photo/Steve Helber)

In all, there are 33 courses at Colorado with 400 students or more. Three have more than 1,200. Most are broken into sections, but even those may have hundreds of students. One chemistry course is so big that the only place on campus where everyone can take the final exam at once is the Coors Event Center, Colorado's basketball arena.

Such arrangements are here to stay on U.S. campuses.

There already are 18 million American college students, and that number is expected to increase by 2 million over the next eight years, as the value of a college degree continues to climb.

To get everyone through their coursework, monstrous class sizes are unavoidable.

That does not have to be a bad thing. At their best, giant classes can be effective and inspiring — a way to get the best teachers in front of the most students.

But according to Carl Wieman, who won the 2001 Nobel Prize as a physicist at Colorado, such successes are rare.

Students often tune out and are turned off. Charismatic lecturers get good reviews but, the data show, are no more effective than others at making the most important concepts stick.

Most remarkably, when it comes to teaching not just "facts" but conveying to students the scientific approach to problem-solving, research shows that

students end up thinking less like professionals after completing these classes than when they started.

"In a very real way, you're doing damage with these courses," Wieman, now a leading voice for reform, said in a recent interview.

Why are so many big classes broken?

One reason is faculty and departments closely guard their absolute power over teaching, and there is no central body nationally or even on campus to direct reform.

Many reforms also take money. If there were enough money, big classes wouldn't exist in the first place.

But state and federal policymakers are clamoring for more accountability and better graduation rates, and if faculty don't step up, bureaucrats might. Big classes are the obvious place to focus. The National Center for Academic Transformation, or NCAT, estimates that the 25 most common college courses — in subjects like economics, English, psychology and the sciences — account for 35 percent of four-year college enrollment nationally. That means a lot of people are taking a relative handful of courses.

Colorado, with a long tradition on innovative science teaching, is one of a number of campuses making significant changes in how at least some large introductory courses are taught and organized. Others include Maryland, MIT, Virginia Tech, Clemson and the University of Alabama.

The reforms go beyond simply reducing class sizes or encouraging lecturers to speak with more animation, though that's an element. Details vary, but one theme is a shift from a passive model of absorbing a lecturer's words to a more active one where lecturers guide and measure, but students learn the material more independently.

It's not necessarily popular with students, but the cognitive research says it is the way to make learning stick.

"In a traditional course the faculty are doing all the work and the students are watching," said Carol Twigg, president and CEO of NCAT, which is working with hundreds of universities to improve giant courses. "In a redesigned course, students are doing the work and faculty are stepping in as needed."

Wieman is at the vanguard of the reform movement, but it's really his second career. In his first he was a researcher with a rare distinction: He produced a new state of matter. Most people know the three most common states of matter — solid, liquid and gas. But cooling rubidium nearly to absolute zero, Wieman and Colorado colleague Eric Cornell formulated the first Bose-Einstein condensate, a state in which several thousand atoms align perfectly and behave as a single "super atom."

After his Nobel, Wieman could easily have focused on lab work or training a cadre of elite graduate students.

But Wieman uses his clout to secure invitations to talk to his fellow scientists — about teaching. He has become one of several physicists to take up the cause, along with Eric Mazur at Harvard, Edward Redish at Maryland and Robert Beichner at North Carolina State.

Wieman wears tennis shoes and walks everywhere like he's in a hurry. He is.

"I have ridiculous, grandiose visions," he said, speaking in his temporary office overlooking Colorado's football stadium. "I want to change how everybody learns science. I won't get into how this will save mankind, but it may."

The problem, he said, is that scientists stop acting like scientists when it comes to their own teaching.

In their own research, scientists hypothesize, measure — then use data to figure out what works. But for teaching, "they're immediately willing to make generalizations about the thousands of students who've been through their class based on the two that talked to them last week," Wieman said.

There's no magic bullet, but measurement is the key.

"We're in this new era of engaging in this as a scholarly enterprise," said Noah Finkelstein, a young Colorado physics professor who has worked with Wieman to revamp a class he teaches. "Most faculty haven't been taught education is a scholarly enterprise. Most faculty have been taught education is an art, not a science."

One of the tools of the new science is "clickers," handheld voting devices now used on at least 700 campuses nationwide, according to manufacturer eInstruction. They let teachers pose mid-lecture multiple choice questions and instantly evaluate if students are grasping the material.

During a recent morning lecture in Colorado's General Chemistry 1131, Professor Robert Parson spoke for a few minutes, then posed a multiple-choice question to the class of about 250. The question, like others he used, was designed by a team of science-learning experts with trick choices that signal if students are falling for common misconceptions. The results of the "vote" popped up on an overhead screen. Then, before revealing the answer, Parson had students break into small groups to discuss the answer and vote again. The group did well, and he moved on. If it had performed poorly, he would have reviewed the material.

Perhaps the biggest challenge in college teaching is bridging the gap between an often brilliant expert and students new to the subject. Clickers help remind teachers how a novice sees their material.

"You realize how many people don't know something you forgot you didn't know 20 years ago," said Barbara Demmig-Adams, one of four Colorado professors who teaches a general biology course with 1,300 students and who introduced clickers this year.

Other campuses are trying different ideas, but a common thread is making big classes more of a two-way street.

At Virginia Tech, for instance, most introductory math courses now take place in a giant room called the "math emporium," in a converted department store just off campus. Students rarely if ever meet together. Instead, they come in any time, 24 hours a day, to work through problems on the 500 computer work stations. When they have a question, they flip over a red plastic cup beside their desk, and helpers — upperclassmen, graduate students or professional staff — come by.

Despite the roomful of computer hardware, the emporium is a much less expensive way to teach — for one course about $24 per student, compared to about $77.

Teaching assistants in Parson's chemistry course and at the math emporium say they're growing increasingly confident in these kinds of methods. But some students are still sour on them.

"I can't do it very well with someone teaching me," said Ian Millington, a Virginia Tech sophomore who failed a calculus class but got a B when he took the same course last summer at a local community college. "So how am I going to teach it to myself?"

His mother, Jennifer Millington, says the family loves everything about Virginia Tech — except how it teaches math.

"If they're going to keep raising the rates, I shouldn't have to be going to a community college to pay for my kid to take calculus," she said. "I know it's a huge school and there are so many students, but if you get so large that you're neglecting the masses (then) kids are falling through the cracks."

Mike Williams, who oversees the emporium, concedes student reaction is mixed. "It turns out many resent they

have to do more work," he said. "They want to sit in a class like they're watching the boob tube."

But he says the popular option isn't always the best way to teach. And it's good for students to take on more responsibility for their learning.

Big lectures have their place, but it's too easy for students to hide, said Lee Shulman, president of the Carnegie Foundation for the Advancement of Teaching. Technology can help if teachers carefully study what works, as Wieman does. Otherwise, the latest gadgets will only further alienate students, as has happened with teachers who rely too much on tools like Microsoft PowerPoint.

Shulman invited Wieman to give his foundation's centennial lecture last year.

"It's not unusual for Nobel laureates to shift the direction of their work into a more socially and educationally focused kind of direction," Shulman said. "What's remarkably different about Carl is that he doesn't just say, 'I'm a Nobel Laureate, listen up,' and then ask people to take teaching more seriously. He approaches it as a scholar."

Frustrated with administrative turnover and funding, Wieman moved his base to the University of British Columbia this year while continuing some of his work at Colorado. He says he was determined to continue his work at a large public university — the kind of place where future K-12 teachers are trained.

If Harvard were to revolutionize introductory science teaching, "people would look at it and say, 'They've got more money than God, that doesn't have any application to us,'" Wieman says. But if places like Colorado and UBC can show measurable improvement, "it's going to be a whole lot harder for people to argue they shouldn't be doing it."

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