Improving the First-Year Experience: The Impact of Course Redesign

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Abstract

Typical failure rates in first-year courses contribute heavily to overall institutional drop-out rates between the first and second year. In partnership with 30 colleges and universities, the Center for Academic Transformation at Rensselaer Polytechnic Institute (RPI) has demonstrated how information technology can be used to improve the quality of student learning, increase retention, and reduce the costs by redesigning large-enrollment introductory courses. Of the 30 projects, 22 have increased student learning and retention; all 30 have reduced their instructional costs. This article discusses six common characteristics all projects share and illustrates how these characteristics play out among urban and metropolitan universities, using five case studies.

Many students who begin postsecondary education drop out before completing a degree. According to the Lumina Foundation, for example, an estimated 60 percent of students at public institutions fail to complete degrees within five years, and half of these students leave during the freshman year. As shown by research by the Policy Center on the First Year of College at Brevard College in North Carolina and others, the first year of college is the most critical to a college student's success and to degree completion.

Successful completion of introductory courses is critical for first-year students, but typical failure rates in these courses contribute heavily to overall institutional drop-out rates between the first and second year. Most of the weaknesses attributed to large introductory courses are generic in nature and have as their source the limitations of the predominant form of instruction in US colleges and universities: the didactic lecture. An overwhelming body of research shows that students do not learn effectively from lectures, and testimony from the field corroborates the literature.

What's wrong with the lecture? The lecture method is a "push" technology. It treats all students as if they were the same, as if they bring to the course the same academic preparation, the same learning style, the same motivation to learn, the same interest in the subject, and the same ability to learn. The reality is that students with weak skills need more individual attention and more opportunity for interaction, particularly at the beginning of the term. At the same time, students with strong skills—those who would benefit from having more opportunity to explore the material fully or who could

accelerate—are locked into a fixed time frame for completing the course. The large, impersonal lecture format simply cannot accommodate the broad range of differences among students.

Most lecture courses are notoriously ineffective in engaging students. Because the lecture is a one-way technology, it cannot make use of sound pedagogical techniques. This format neither encourages active participation nor offers students an opportunity to learn collaboratively from one another. It does not provide adequate tutoring assistance, and consequently, students receive little individual attention. Even though individual help may be available during office hours, only a small fraction of students take advantage of this help. Most students simply study the text, turn in their homework, and take quizzes and exams. Heavy reliance on reading assignments leads to inadequate student interaction with learning materials. Adding to the lack of feedback is the way in which most tests are graded: students receive only the total score and never know which material was incorrect or where to learn the correct information.

As a result, in many institutions, attendance at large lecture sections averages 50 percent, compared with attendance at moderate-sized sections, often averaging better than 75 percent. Although success rates vary by institutional type and by subject matter, Research I universities commonly cite a 15 percent rate of drops, D grades, and failures in lecture courses. Comprehensive universities report success rates (a grade of C or better) ranging from 78 percent down to 55 percent in these courses. Community colleges frequently experience retention rates of 60 percent or less.

Even more important, students who pass large lecture courses often do not retain much of the material for future use in other courses. All institutions report the inability of students to retain what they have learned in large lecture courses and, more specifically, the inability of students to apply the principles learned to other disciplines. Lee Shulman, president of the Carnegie Foundation, has described these learning problems as the "epidemiology of mislearning" or the "taxonomy of pedagopathology." Students forget what they learned (amnesia); they don't understand that they misunderstand what they learned (fantasia); and they are unable to use what they learned (inertia). The irony of this situation is that large lecture courses are used most frequently in introductory subjects with the weakest students (non-majors), whereas small interactive courses predominate in those areas with the strongest students (students in a senior seminar).

The primary alternative structure for large-enrollment courses, the multiple-section model, suffers from problems of its own. In theory it allows greater interaction with students, but in practice, the sections are often quite large and are dominated by the same presentation techniques as used in larger courses. In addition, the multiple-section model suffers from a lack of coordination. Whether taught by tenured faculty, instructors, adjuncts, or graduate teaching assistants, this model requires each instructor to develop his or her own set of course materials, including tests and examinations, and to deliver what is basically the same material in his or her own

style. As a result, course outcomes vary considerably and, more important, are not always consistent with students' abilities. Multiple sections with no common approaches produce a remarkable lack of uniformity in outcomes. When courses are taught this way, the intellectual resources of the faculty cannot be pooled to achieve the best course design and to institute continuous improvement practices.

The Solution

Supported by an $8.8 million grant from the Pew Charitable Trusts, the Program in Course Redesign (http://www.center.rpi.edu/PewGrant.html) was created in April 1999 to demonstrate how information technology could be used to address the significant academic problems experienced by first-year students at most institutions. The program is managed by the Center for Academic Transformation (http://www.center.rpi.edu/) at Rensselaer Polytechnic Institute (RPI). Many colleges and universities have discovered exciting new ways of using technology to enhance teaching and learning and to extend access to new populations of students. For most institutions, however, new technologies represent a black hole of additional expense. This is because the majority have simply bolted new technologies onto an existing set of physical facilities, a faculty already in place, and an unaltered concept of classroom instruction. Under these circumstances, technology becomes part of the problem of rising costs rather than part of the solution.

In addition, comparative research studies show that, instead of improving quality, most technology-based courses produce learning outcomes that are only "as good as" their traditional counterparts—what has come to be known as the "no significant difference" phenomenon. By and large, colleges and universities have not yet begun to realize the promise of technology to improve the quality of student learning, increase retention, and reduce the costs of instruction. In contrast, the goal of the Program in Course Redesign is to support colleges and universities in their efforts to redesign instruction using technology to achieve quality enhancements *as well as* cost savings.

Selected from hundreds of applicants in a national competition, 30 institutions each received a grant of $200,000, awarded in three rounds of 10 per year. Participating institutions include research universities, comprehensive universities, independent colleges, and community colleges in all regions of the United States. Detailed descriptions of each redesign project can be found on the Center Web site.

All 30 redesign projects focus on large-enrollment introductory courses. Why focus on such courses? In addition to addressing the high rate of academic failure endemic to these courses, changes in these courses have the potential to affect significant student numbers and generate substantial cost savings. Undergraduate enrollments in the United States are concentrated heavily in only a few academic areas. In fact, just 25 courses generate about half of all student enrollments in community colleges and about a third of enrollments in four-year institutions. The topics of these courses are no surprise and include introductory studies in disciplines such as English, mathematics, psychology, sociology, economics, accounting, biology, and chemistry.

The insight that these figures point to is simple and compelling: in order to have a significant impact on large numbers of students, an institution should concentrate on redesigning the 25 courses in which most students are enrolled instead of putting a lot of energy into improving quality or cutting costs in disparate small-enrollment courses. By making improvements in a restricted number of large-enrollment prerequisite or introductory courses, a college or university can literally affect every student who attends.

Twenty-two of the 30 projects involved in the program have shown statistically significant increases in student learning; the other 10 have shown equivalent learning to traditional formats. All 30 projects have reduced their instructional costs, on average about 40 percent. Of the 24 projects that measured retention, 22 have thus far reported a noticeable decrease in drop-failure-withdrawal (DFW) rates, ranging from 10 to 20 percent, and higher course-completion rates. Other positive outcomes associated with redesigned courses include better student attitudes toward the subject matter and increased student satisfaction with the new mode of instruction.

The Program in Course Redesign has produced many different models of how to restructure such courses to improve learning as well as to effect cost savings. In contrast to the contention that only certain kinds of institutions can accomplish these goals, and in only one way, the program is demonstrating that many approaches can achieve positive results. And to counter the belief that only courses in a restricted subset of disciplines—science or math, for instance—can be effectively redesigned, the program contains successful examples in many disciplines including the humanities (6), math and statistics (13), the social sciences (6), and the natural sciences (5).

Common Characteristics

What do these projects have in common? To one degree or another, all 30 projects share the following six characteristics:

1. *Whole course redesign.* In each case, the whole course—rather than a single class or section—is the target of redesign. Faculty begin the design process by analyzing the amount of time that each person involved in the course spends on each kind of activity, a process that often reveals duplication of effort among faculty members. By sharing responsibility for both course development and course delivery, faculty save substantial amounts of time while achieving greater course consistency.

2. *Active learning.* All of the redesign projects make the teaching-learning enterprise significantly more active and learner-centered. Lectures are replaced with a variety of learning resources that move students from a passive, note-taking role to an active, learning orientation. As one math professor put it, "Students learn math by doing math, not by listening to someone talk about doing math."

3. *Computer-based learning resources.* Instructional software and other Web-based learning resources assume an important role in engaging students with course

content. Resources include tutorials, exercises, and low-stakes quizzes that provide frequent practice, feedback, and reinforcement of course concepts.

4. *Mastery learning.* The redesign projects add greater flexibility for when students can engage with a course, but the redesigned courses are not self-paced. Rather than depending on class meetings, student pacing and progress are organized by the need to master specific learning objectives, which are frequently in modular format, according to scheduled milestones for completion.

5. *On-demand help.* An expanded support system enables students to receive assistance from a variety of different people. Helping students feel that they are a part of a learning community is critical to persistence, learning, and satisfaction. Many projects replace lecture time with individual and small-group activities that take place either in computer labs—staffed by faculty, graduate teaching assistants (GTAs), and/or peer tutors—or online, enabling students to have more one-on-one assistance.

6. *Alternative staffing.* By constructing support systems consisting of various kinds of instructional personnel, the projects apply the right level of human intervention to particular student problems. Not all tasks associated with a course require highly trained, expert faculty. By replacing expensive labor (faculty and graduate students) with relatively inexpensive labor (undergraduate peer mentors and course assistants) where appropriate, the projects increase the person-hours devoted to the course and free faculty to concentrate on academic rather than logistical tasks.

Although all 30 projects have these characteristics in common, each has chosen a design model that implements the characteristics in a way that varies according to the discipline involved, the particular student audience, and the preferences of faculty. To illustrate specifically how these characteristics play out among urban and metropolitan universities, five case studies of redesign projects conducted by Florida Gulf Coast University, Indiana University–Purdue University at Indianapolis, Portland State University, the University of Central Florida and the University of New Mexico are presented with this article. These universities are experiencing the generic quality and cost problems faced by all colleges and universities, but they also face problems unique to their urban setting.

Some of the particular problems confronting urban and metropolitan universities addressed by the redesign projects are:

- the need for more flexible schedules for commuting student populations, particularly for working adult students who cannot attend on a regular basis;
- the special needs of English-as-second-language students, who often have a difficult time with courses requiring considerable language facility and use of technical terms, particularly when they are taught in a stand-up format;
- the need to create a greater sense of community or engagement for commuting students; and

- the need to accommodate growth in student demand in more creative and cost effective ways than traditional methods.

Design Principles that Contribute to Student Success

Improved Student Learning

By effecting significant changes in the teaching and learning process, making it more active and learner-centered, it is possible to improve student learning and reduce student failure. Each of the 30 participating institutions is conducting a rigorous evaluation focused on student learning, comparing the outcomes of redesigned courses with those of courses with the same content delivered in a traditional (pre-redesign) format. Preliminary results show improved student learning in 20 of the 30 projects, with the remaining 10 showing learning equivalent to the traditional format.

Many of the projects show statistically significant improvements in overall student understanding of course content as measured by pre- and post- assessments that examine key course concepts. For example, at the University of Central Florida, students enrolled in a traditionally configured political science course posted a 1.6-point improvement on a content examination, while the average gain of 2.9 points for students in the redesigned course was almost double that amount. The University of Tennessee, Knoxville found a significant and favorable 5-point difference between student scores on a redesigned course exam in Spanish and the scores of students enrolled in traditional sections.

Other projects demonstrate statistically significant improvements in student understanding of course content by comparing the performance of students enrolled in traditional and redesigned courses on commonly administered examinations. Redesign-course students in statistics at Penn State, for example, outperformed traditional students on a content-knowledge test, with 60 percent correct answers in the traditional format and 68 percent correct in the redesigned classes. At Carnegie Mellon University, the performance of redesign-course students in statistics increased by 22.8 percent on tests of skills and concepts, and redesign-course students also demonstrated an enhanced ability to identify the appropriate statistical analysis to employ in a given real-world problem situation. At Florida Gulf Coast University (FGCU), the average score achieved on a commonly administered standardized test by students enrolled in the traditional fine arts course was 72 percent; in the redesigned course it was a significantly higher 85 percent.

Most of the projects also reported significant improvements in their drop-failure-withdrawal (DFW) rates. At the University of Southern Maine (USM), a smaller percentage of introductory psychology students dropped the redesigned course or received failing grades, moving the DFW rate from 28 percent in traditional sections to 19 percent in the redesigned course. At Virginia Tech, the percentage of students completing a redesigned linear algebra course and achieving grades of D- or better

improved from an average of 80 percent to an average of 87 percent. At the University of Idaho, the percentage of students earning a D or failing was cut by more than half. Drexel University reduced its DFW rate in computer programming from 49 to 38 percent, FGCU from 37 to 10 percent in fine arts, Indiana University–Purdue University Indianapolis (IUPUI) from 39 to 25 percent in introductory sociology, and the University of New Mexico from 42 percent to 18 percent in psychology.

What techniques have the projects found to be the most effective in improving student learning? The most prominent are the following:

- *Continuous Assessment and Feedback.* Shifting the traditional assessment approach in large introductory courses, which typically employ only midterm and final examinations, toward continuous assessment is an essential pedagogical strategy in these redesigns. Many of the projects include numerous computer-based assessments that give students almost instantaneous feedback on their performance. Automating assessment and feedback enables repeated practice as well as providing prompt and frequent feedback—pedagogical techniques that research consistently has proven to enhance learning.

  Students are regularly tested on assigned readings and homework using short quizzes that probe their preparedness and conceptual understanding. These low-stakes quizzes motivate students to keep on top of course material, structure how they study, and encourage them to spend more time on task. Online quizzing encourages a "do it till you get it right" approach: students are allowed to take quizzes as many times as they want to, until they master the material.

  Quizzes also provide powerful formative feedback to both students and faculty members. Faculty can quickly detect areas where students are not grasping key concepts, enabling timely corrective intervention. Students receive detailed diagnostic feedback that points out why an incorrect response is inappropriate and directs them to material that needs review. Since students are required to complete quizzes before class, they are better prepared for higher-level activities once they get there. Consequently, the role of the instructor shifts from one of introducing basic material to reviewing and expanding what students have already been doing.

- *Increased Interaction among Students.* Many redesign projects take advantage of the Internet's ability to support useful and convenient opportunities for discussion among students. Students in large lecture classes tend to be passive recipients of information, and student-to-student interaction is inhibited by class size. Through smaller discussion forums established online, students can participate actively. Central Florida and IUPUI create small online discussion groups in which students can easily contact one another in their redesigned American government and introductory sociology courses. Students benefit from participating in the

informal learning communities that are created in this manner. Software allows instructors to monitor the frequency and quality of student contributions to these discussions more readily and carefully than would be the case in a crowded classroom.

- *Continuous Support.* A support system, available around the clock, enables students to receive help from a variety of sources. Helping students feel that they are a part of a learning community is critical to persistence, learning, and satisfaction. Active mentorship of this kind can come from a variety of sources, allowing students to interact with the person who can provide the best help for the specific problem they have encountered.

  Many of the redesign projects replace lecture time with individual and small-group activities that take place in computer labs staffed by faculty, graduate teaching assistants (GTAs) and/or peer tutors. In several instances, increasing lab hours has enabled students to get access to more one-on-one assistance. Students welcome the reduction in lecture time and the opportunity to work in groups to apply what they have learned. Collaboration also triggers peer pressure within groups, which can be a powerful incentive for students to keep up with their work.

- *Online Tutorials.* In redesign courses, Web-based resources that support greater student engagement with the material replace standard presentation formats. Such resources may include interactive tutorials and exercises that give students needed practice; computerized or digitally recorded presentations and demonstrations; reading materials developed by instructors or in assigned textbooks; examples and exercises in the student's field of interest; links to other relevant online materials; and individual and group laboratory assignments.

  Ideally, materials like these are modularized and tailored to incorporate examples drawn from a variety of disciplines to match the learning circumstances of students with different professional and personal goals. Using modularized materials also allows changes in content or format if students are having difficulty understanding a particular part of the course.

  The University of Wisconsin at Madison and Virginia Tech are among the most sophisticated users of online tutorials. Building on substantial experience in using and developing interactive materials, Wisconsin had developed 37 Web-based instructional modules in chemistry by July 2001. Each module leads a student through a particular topic in six to 10 interactive pages. When the student has completed the tutorial, a debriefing section presents a series of questions that test whether the student has mastered the module's content. Students especially like the ability to link from a problem they have difficulty with directly to a tutorial that helps them learn the concepts needed to solve the problem.

Virginia Tech uses a variety of Web-based course-delivery techniques like tutorials, streaming video lectures, and lecture notes as tools for presenting materials in a linear algebra course. Consisting of concrete exercises with solutions that are explained through built-in video clips, such tutorials can be accessed at home or at a campus lab. In redesigned courses, tutorials have taken over the main instructional task with respect to transmitting content; 84 percent of the students enrolled in Virginia Tech's linear algebra course reported that the computer presentations explain the concepts effectively.

- *Undergraduate Learning Assistants (ULAs).* Both the University of Colorado-Boulder (UC) and SUNY at Buffalo (UB) are employing ULAs in lieu of Graduate Teaching Assistants (GTAs). Both universities have found that ULAs turned out to be better at assisting their peers than GTAs because of the ULAs' understanding of the course content, their superior communication skills, and their awareness—based on their own recent experience—of the many misconceptions that undergraduate students often hold.

  In Colorado's redesigned introductory astronomy course, the instructor meets weekly with the ULAs and discusses in detail what is working and where students are having difficulty. Feedback from these weekly meetings gives the instructor a much better sense of the class as a whole, and of the individual students in it, than would otherwise be possible with a class of more than 200 students.

People who are knowledgeable about proven pedagogies that improve student learning will find nothing surprising in the above list. Among the well-accepted *Seven Principles for Good Practice in Undergraduate Education* developed by Arthur W. Chickering and Zelda F. Gamson in 1987 are such items as "encourage active learning," "give prompt feedback," "encourage cooperation among students," and "emphasize time on task." Good pedagogy in itself has nothing to do with technology. What is significant about the faculty involved in these redesigns is that they were able to incorporate good pedagogical practice into courses with *very large numbers of students*—a task that would have been impossible without technology.

In the traditional general chemistry course at the University of Iowa, for example, previously 21 GTAs were responsible for grading more than 16,000 homework assignments each term. Because of the large number of assignments, GTAs could only spot-grade and return a composite score to students. By automating the homework process through redesign, every problem is graded and students receive specific feedback on their performance. This, in turn, leads to more time on task and higher levels of learning. Applying technology is not beneficial without good pedagogy. But technology is essential to move good pedagogical practice to scale, where it can affect large numbers of students.

Reduced Instructional Costs

Each institution has also developed a detailed cost analysis of both the traditional and redesigned course formats, using a spreadsheet course-planning tool (http://www.center.rpi.edu/PewGrant/Tool.html) developed by the Center. Preliminary results show that all 30 reduced costs by 40 percent on average, with cost savings ranging from 20 to 77 percent. Collectively, the 30 redesigned courses impact more than 50,000 students and produce a cost savings of $3.6 million each year—while improving student-learning outcomes and increasing retention at the same time.

There are a variety of ways to reduce costs. There are also a variety of strategies for pursuing instructional redesign, depending upon institutional circumstances. For instance, an institution may want to maintain constant enrollments while reducing the total amount of resources devoted to the course. By using technology for those aspects of the course where it would be more effective and by engaging faculty only in tasks that require faculty expertise while transferring other tasks that are less academically challenging to those with a lower level of education, an institution can decrease costs per student even though the number of students enrolled in the course remains unchanged. This approach makes sense when student demand for the course is relatively stable.

But if an institution is in a growth mode or has more demand than it can meet through existing course delivery, it may seek to increase enrollments while maintaining the same level of investment. Many institutions have escalating demand for particular subjects like Spanish or information technology that they cannot meet because they cannot hire enough faculty members. By using redesign techniques, they can increase the number of students they enroll in such courses and relieve these academic bottlenecks without changing associated costs. Portland State University, for example, has been able to almost double the number of students served in a year-long introductory Spanish course, while only slightly increasing the number of instructional staff.

Another way to reduce costs is to decrease the number of course repetitions due to failure or withdrawal, so that the overall number of students enrolled each term is lowered and the required number of sections (and the faculty members to teach them) are reduced. At many community colleges, for example, it takes students about two-and-a-half tries to pass introductory math courses. If an institution can move students through in a more expeditious fashion by enabling them to pass key courses in fewer attempts, this will generate considerable savings—both in terms of institutional resources and in terms of student time and tuition.

As noted earlier, 22 of the 24 projects that measured retention have thus far reported a noticeable decrease in DFW rates, ranging from 10 to 20 percent. As an example of the levels of resources that can be saved, Central Florida has calculated the savings resulting from a 7 percent increase in course retention in its American government course. Applying this rate to 25 redesigned sections results in a one-course-section reduction, amounting to a $28,064 cost savings each time the course is offered.

Not surprisingly, many of the redesign projects are trying several of these approaches to saving resources simultaneously. All intend to reduce course repetitions. In each case, a translation of the savings to cost-per-student can be used for comparative purposes.

What are the most effective cost-reduction techniques used by the redesign projects? Since the major cost item in instruction is personnel, reducing the time that faculty members and other instructional personnel invest in the course, and transferring some of these tasks to technology-assisted activities are key strategies. Some of the more predominant cost-reduction techniques used by the projects include:

- *Online Course-Management Systems.* Course management systems—software packages that are designed to help faculty members transfer course content to an online environment and assist them in administering various aspects of course delivery—play a central role in most of the redesigns. Some projects use commercial products like WebCT and Blackboard; others use homegrown systems created centrally for campuswide use or specifically for the redesigned course. Still others use instructional software that includes an integrated course-management system. Sophisticated course-management software packages enable faculty members to monitor student progress and performance, track their time on task, and intervene on an individualized basis when necessary.

  Course management systems can automatically generate many different kinds of tailored messages that provide needed information to students. They can also communicate automatically with students to suggest additional activities based on homework and quiz performance, or to encourage greater participation in online discussions. Using course-management systems radically reduces the amount of time that faculty members typically spend in nonacademic tasks like calculating and recording grades, photocopying course materials, posting changes in schedules and course syllabi, sending out special announcements to students—as well as documenting course materials like syllabi, assignments, and examinations so that they can be used in multiple terms.

- *Automated Assessment of Exercises, Quizzes, and Tests.* Automated grading of homework exercises and problems, of low-stakes quizzes, and of examinations for subjects that can be assessed through standardized formats not only increases the level of student feedback, but also offloads these rote activities from faculty members and other instructional personnel. Some of the projects use the quizzing features of commercial products like WebCT. Others use specially developed grading systems like Mallard at the University of Illinois. Still others use quizzing software like TESTPILOT, while additional projects take advantage of the online tests that are available from textbook publishers.

Online quizzing sharply reduces the amount of time faculty members or GTAs need to spend on the laborious process of preparing quizzes, grading them, and recording and posting the results. Automated testing systems that contain large numbers of questions in a database format enable individualized tests to be easily generated, then quickly graded and returned.

- *Online Tutorials.* Modular tutorials are designed to lead a student through a particular topic that is presented through interactive online or CD-ROM-based materials. When students have completed the tutorial, they are presented questions that test whether they have mastered the content of the module. Online tutorials at Wisconsin help structure subsequent discussion sections by raising the probability that students will come to class prepared to ask questions. This means less preparation time for GTAs.

  Virginia Tech's use of similar online course delivery techniques in its linear algebra course has enabled radical reductions in teaching staff. Individual faculty members are no longer required to present the same content through duplicative efforts. Nor do they need to replicate exercises and quizzes for each section. Interactive tutorials can replace part—and, in some cases, all—of the "teaching" portions of the course.

- *Shared Resources.* When an entire course (or more than one section) is redesigned, faculty must begin by analyzing the amount of time that each person involved in the course spends doing each activity. This highly specific task analysis often uncovers instances of duplicated effort and can lead to shared, and more efficient, approaches to course development. The often substantial amounts of time that individual faculty members spend developing and revising course materials and preparing for classes can be reduced considerably by eliminating such duplications.

  For example, Penn State has constructed an easy-to-navigate Web site for its introductory statistics course that contains not only material on managing the course but also a large number of student aids and resources, including solutions to problems, study guides, supplemental reading materials for topics not otherwise treated in the text, and student self-assessment activities. Putting assignments, quizzes, exams, and other course materials on a community Web site for the course, can save a considerable amount of instructional time.

- *Staffing Substitutions.* By constructing a support system that comprises various kinds of instructional personnel, institutions can apply the right level of human intervention to particular kinds of student problems. Highly trained (and expensive) faculty members are not needed to support all of the many tasks associated with delivering a course. The University of Colorado, SUNY at Buffalo, Virginia Tech, and Penn State are employing ULAs in lieu of GTAs as a key cost-saving device. By replacing expensive faculty

members and graduate students with relatively inexpensive labor, an institution can increase the person-hours devoted to the course and at the same time cut costs.

Although the employment of ULAs was in these cases originally driven by the need to reduce costs, ULAs have also proven more effective than most GTAs, as noted earlier. Another solution, implemented by Rio Salado College, is to employ a "course assistant" to address the many nonacademic questions that arise as any course is delivered—questions that can characterize up to 90 percent of staff interactions with students. This frees the instructor to handle more students and to concentrate on academic interactions rather than logistics.

- *Reduced Space Requirements.* Using the Web to deliver particular parts of a course as a substitute for face-to-face classroom instruction enables institutions to use classroom space more efficiently. Because one of the goals of its redesign was to reduce the amount of rented space needed, the University of Central Florida delivers portions of its American government course via the Web. Two or three course sections can be scheduled in the same classroom where only one could be scheduled before. Central Florida is the only project that detailed the specific cost savings that resulted from better use of space, but any of the projects that reduced contact hours generated space savings as well.

With regard to cost savings, the redesign methodology is an unqualified success. Redesigned courses are reducing costs by an average of 40 percent, with specific savings ranging from 20 percent to 77 percent. Collectively, the 30 courses are expecting a savings of about $3.6 million annually. Some are saving more than they planned to; others less. Round I projects planned to reduce costs by about 37 percent, with a range of 20 percent to 71 percent. They actually reduced costs by 33 percent on average, with a range of 16 percent to 77 percent. Round II projects planned to reduce costs by about 44 percent, with a range of 20 percent to 84 percent. They actually reduced costs by 38 percent on average, with a range of 25 percent to 74 percent. Round III projects are on track in their plans to reduce costs, but final results are not yet available.

Why is there such a large range in cost savings across the projects? Differences are directly attributable to the different design decisions made by the project teams, especially with respect to how to allocate expensive faculty members. Redesigns with lower savings tended to redirect, not reallocate, saved faculty time; they keep the total amount of faculty time devoted to the course constant, but they change the way faculty members actually spend their time (for example, lecturing versus interacting with students). Both UCF and IUPUI, for example, followed that strategy, and their cost reduction percentages are 28 percent and 20 percent respectively.

Others substantially reduce the amount of time devoted to the course by non-faculty personnel like GTAs, but keep the amount of regular faculty time constant. Decisions like these reduce total cost savings. By radically reallocating faculty time to other courses and activities, in contrast, Virginia Tech shows cost savings of 77 percent in its redesigned linear algebra course—thus far the most substantial cost savings among the 30 projects. But most of the other projects could have saved more with no diminution in quality, if they had made different design decisions.

Conclusion

American colleges and universities continue to be challenged by the need to increase access to higher education, to improve the quality of student learning, and to control or reduce the rising cost of instruction. These issues are, of course, interrelated. As tuition costs continue to rise, access is curtailed. If the quality of the curriculum inhibits students from successfully completing courses and programs, promises of increased access become hollow.

Solutions to these challenges appear to be interrelated as well. Historically, either improving quality or increasing access has meant increasing costs. Reducing costs, in turn, has meant cutting quality, access, or both. In order to sustain higher education's vitality while serving a growing and increasingly diverse student body, it must find a way to resolve this familiar—and seemingly intractable—trade-off between cost and quality.

By using technology-based approaches and learner-centered principles to redesign their courses, the 30 institutions involved in the Program in Course Redesign are showing us a way out of higher education's historical trade-off between cost and quality. Some of them rely on asynchronous, self-paced learning modes, while others use traditional, synchronous classroom settings but with reduced student/faculty contact hours. Both approaches start with a careful look at how best to deploy *all* available instructional resources to achieve the desired learning objectives. Questioning the current credit-for-contact paradigm of instruction, and thinking systematically about how to produce more effective and efficient learning, are fundamental conditions for success.

Higher education has traditionally assumed that high quality means low student-faculty ratios, and that large lecture-presentation techniques supported by cheap labor constitute the only viable low-cost alternatives. But it is now clear that course redesign using technology-based, learner-centered principles can offer higher education a way out of this historical trade-off between cost and quality. New models demonstrate that it is indeed possible to improve learning and reduce costs at the same time. For the first time, we can have our cake and eat it too.

Case Studies

CASE STUDY 1: Florida Gulf Coast University

Opened in 1997, Florida Gulf Coast University (FGCU), a four-year public institution and the tenth university in the state university system, was established to serve the needs of the southwest Florida region, one of the fastest growing areas in the United States. Located in Fort Myers, FGCU has experienced phenomenal growth in the six years since its opening, with student enrollment increases of 12.6 percent, 25.9 percent and 27.6 percent for the past three years. The university expects an enrollment of 3,300 FTE students for the 2003–2004 academic year. Because the mission of the university holds that "Learner needs, not institutional preferences, will determine priorities for academic planning," FGCU is committed to increasing access to quality academic programs that emphasize student learning while controlling costs through creative teaching and course delivery practices.

As part of the Program in Course Redesign, FGCU redesigned its Understanding the Visual and Performing Arts course, a required course in its general education program, in order to accommodate enrollment growth and achieve greater coherence and consistency. The course was designed to allow students to develop a broad-based understanding of the visual and performing arts, the critical and creative thinking skills to engage actively in a critique of the arts, and a desire and willingness to participate in the arts. FGCU's goal was to create a structured learning environment using technology that increased student learning while controlling instructional costs.

The Traditional Course

The traditional version of Understanding the Visual and Performing Arts was taught primarily in face-to-face sections of 30 students each. Two distance sections of 15 students each were also taught each semester. The traditional course faced both academic and resource problems. Because the course utilized a large number of adjuncts (approximately two-thirds of the sections were taught by adjuncts), there was significant course drift, reflecting inconsistent, uncoordinated coverage of the several topics and yielding uneven learning. Some adjuncts did not adhere to the course's learning goals and objectives, and a few did not use the selected text. Many of adjuncts had expertise in only one art form and lacked the breadth to teach the wide range of the arts covered in the course.

Given the 30-student section model, significant increases in enrollments required growing numbers of small sections, thus exacerbating the problem. The number of sections grew from seven sections enrolling 180 students in the 1997–1998 academic year to 31 sections enrolling 800 students in 2001–2002, and that growth

rate is expected to continue. The distance sections were especially work-intensive and expensive to offer in that they served small numbers of students. The resources available to offer increasing numbers of sections of this required course were limited.

The Redesigned Course

FGCU's goal for the redesigned course was to increase the number of students receiving As and Bs and decrease the number of those receiving Ds and Fs. All students were moved into a single, fully online section, using a common syllabus, textbook, set of assignments,and course Web site. Students were placed into cohort groups of 60 and, within these groups, Peer Learning Teams of six students each. The redesign allowed FGCU to maintain the most important elements of humanities courses—the active engagement with ideas and a collaborative and experiential learning experience—while eliminating seat time completely.

The redesigned humanities course included three modules: one focused on Visual Arts, one on Performing Arts, and one on the historical contexts of interrelated art forms. Faculty experts redesigned the course, and outside experts critiqued the content. Each of the three modules had the same format:

- Students completed the learning activities, including reading assigned chapters in the text and completing practice tests multiple times. These tests were low-stakes quizzes that provided students with feedback on their learning in preparation for the objective portion of the module exam.
- Students engaged in Web board discussion and analyzed sample short essays in preparation for the short essay portion of a module exam.
- Students completed a preliminary exam.
- Students completed a module exam, which included objective questions and a short essay question.
- Students attended two arts activities in the community to gather material for two longer critical analysis essays.

Short essays in the module exams were evaluated using the Intelligent Essay Assessor (IEA), a computer program designed to grade well-structured essays. The IEA, once programmed, assesses 100–500-word student essays based on content, grammar, punctuation, mechanics, and spelling. In order to program the IEA, the FGCU team entered a digitized version of the textbook and a minimum of 200 essays scored holistically by the design team. Once programmed, the software was able to grade the short essay questions and provide a score.

The team was able to demonstrate a high level of inter-rater reliability between the IEA and human scoring. For the holistic scoring process, the team read and scored a total of 803 essays that were then fed into the IEA. Of those essays, 435 were given the same score on the first two reads, a 54 percent inter-rater reliability. Of the 817

total essays that were read in the holistic scoring process, 508 were given the same score by the IEA as that given by humans, a 62 percent inter-rater reliability. The team then went back and reread the 309 essays that were given a different score. Of those essays, 151 scores were changed to bring them in line with the IEA score, producing a final IEA-human inter-rater reliability of 81 percent.

Students also demonstrated their learning through a series of structured critical analysis essays. Before writing their own short essays on the module exams, students completed Web board discussions with their Peer Learning Teams where they analyzed two sample essays, one of which was strong and the other weak. Students had to determine which was strong and which was weak and explain why. One student from each team posted a summary of their discussion to the Class Discussion List. The online, peer discussion provided the students with guidance on how to analyze works of art, increased interaction among students, created an atmosphere of active learning, and developed students' critical thinking skills.

The redesigned course was taught by rotating full-time faculty members working with a course coordinator and a group of preceptors. The faculty member provided intellectual leadership to the course, while the course coordinator oversaw the administrative aspects of the course. Preceptors were responsible for interacting with students, monitoring student progress, and grading critical analysis essays based on pre-established rubrics.

Improved Learning

FGCU assessed the development of content knowledge primarily through three multiple-choice exams, but also through the application of the content knowledge in short essays analyzing artwork. In the area of content knowledge, students demonstrated a markedly enhanced level of learning in the redesigned course. The average score on the standardized exams in the traditional courses was 72 percent; in the redesigned course it was 85 percent. Further increases are documented in the grade distribution. The percentage of As and Bs on the standardized exams went from 37 percent in the traditional course to 77 percent in the fully implemented. The percentage of Ds and Fs went from 37 percent in the traditional to 10 percent in the redesigned course.

In addition to expecting students to learn a great deal of content knowledge, FGCU also expected them to apply that knowledge in analyzing works of art. A second component of the module exams was short essay questions where students were asked to analyze a work of art using the elements that they learned about in the text. The short essay questions were scored using the IEA on a 4-point scale (4 = A, 3 = B, 2 = C, 1 = D/F). Again, the students did remarkably better in the redesigned course:

	4	3	2	1
Traditional	6 percent	26 percent	46 percent	21 percent
Redesign	8 percent	39 percent	45 percent	8 percent

Finally, FGCU assessed the development of attitudes toward the arts through pre- and post-tests and journals. Analysis indicated a clear increase in students' positive attitudes toward the visual and performing arts in the redesigned course. In many cases, students entered the class believing that they already had a good background in the arts, thinking that they were not going to learn much. Invariably, when they left, they admitted that their knowledge had increased and with it a willingness to attend arts activities. Students were surprised by how much they had learned. Based on the pre- and post-tests, the journals, and the focus groups, the FGCU team was able to demonstrate that students learned more than they had expected to learn.

The FGCU team cites two techniques that most contributed to improving the quality of student learning: the Web board discussions of sample short essays and the low stakes practice quizzes. As noted above, students in the redesign course did extremely well on the short essays for the exams, scoring on average one full letter grade higher than in the face-to-face classes taught by adjuncts. The reason for this is clear—the students were able to see and analyze a model essay before they wrote their own. While the sample essays had been provided to the instructors of traditional sections, they either did not use them or did not emphasize them.

Students completed practice quizzes in order to prepare for the objective questions on the module exams. Questions on the objective portions of the module exams drew questions from the practice test banks. The practice quizzes could be taken as many times as the student wanted; the highest score achieved on the practice test was the score recorded. After students completed a practice test, they were provided with detailed feedback. Students who took the practice exams repeatedly scored the highest on the module exams.

In the course redesign pilot, practice tests only counted as part of students' participation grade. Because of this, students only needed to take the practice tests once—regardless of how they scored—to get full credit. FGCU changed its strategy in the full implementation of the redesign; each course activity that the students needed to complete was assigned a point value. As a result, students began to take the assignments more seriously, banking their points as they progressed through the semester. Students took the practice tests repeatedly, some taking them as many as 25 times. Those students who took the practice tests three or more times regularly scored As on the module exams.

Reduced Costs

The cost savings at FGCU were attributable to two factors: making changes in the course itself and creating a model that allows for significant growth. Regarding the first factor, the course redesign off-loaded many labor-intensive activities to technology such as presenting content information and grading exams and essays, thus reducing the hours spent by full-time faculty from 950 to 300. The use of WebCT to create test banks and deliver the practice tests and module exams was one of the greatest techniques for reducing the cost of the course. In addition, WebCT housed a great deal of other course-related information that students could easily access. The use of the IEA reduced the need for human reading of essays. The total course delivery time decreased by more than 400 hours, while the number of students increased by 150. The result was a 40 percent reduction in the cost-per-student from about $132 to $81 in the first full year of the redesign.

FGCU used an alternative staffing model that made the best use of personnel (the faculty, course coordinator, and preceptors) with differentiated roles. The course was taught by a single full-time faculty member, which ensured that all students received a similar learning experience. The full-time faculty member was responsible for updating the syllabus and other Web materials; for answering students questions regarding exams and assignments; and for overseeing the preceptors. The faculty member worked closely with a full-time course coordinator who was responsible for the logistical and administrative aspects of the course. The preceptors, most of whom have a B.A. in English, were responsible for overseeing four Web board discussions and for grading the critical analysis essays. FGCU's initial plan expected that six preceptors would handle eight peer learning teams or 48 students each and would be paid $1,800 per group. However, based on workload evaluations by the preceptors, each preceptor now works with 10 peer learning teams or 60 students. (In contrast, the adjuncts who taught the traditional course were paid $2,200 per section of 30 students.)

The redesign model allows FGCU to continue to scale by adding preceptors while maintaining important faculty oversight via the course coordinator and ongoing faculty curricular review. Had the institution responded to the growth demand by continuing to hire adjuncts and employ full-time faculty as in the traditional format, the anticipated increase in student numbers would have become much more expensive and difficult to sustain. Thus, part of FGCU's savings in subsequent years will result from the opportunity cost of not having to accommodate growth by recruiting and hiring adjuncts. Instead, their redesign model permits costs to increase at a much slower pace.

Because the course is entirely online, FGCU no longer needs to use classroom space for this course, thus alleviating a space crisis because enrollment has grown at a faster pace than buildings. Eliminating course drift and offering all students the

same set of course experiences has improved quality for all, whether students are studying on or off campus. All students registering for the course now receive the same content information and have the same assessment experiences, allowing FGCU to be certain that students can meet the learning goals and objectives developed for the course.

CASE STUDY 2: Indiana University–Purdue University Indianapolis

Located in Indianapolis, Indiana University–Purdue University at Indianapolis (IUPUI) is an urban research university created in 1969 as a partnership by and between Indiana and Purdue Universities, with IU as the managing partner. Because it grants degrees in 185 programs from both Indiana University and Purdue University, IUPUI offers the broadest range of academic programs of any campus in Indiana and is the state's principal site for graduate professional education with statewide programs in medicine, dentistry, nursing, allied health, and social work. IUPUI ranks among the top fifteen in the country in the number of first professional degrees it confers and among the top five in the number of health-related degrees. Student headcount reached an all-time high in Fall 2002, with 21,060 undergraduate and 7,965 graduate/professional enrollments.

As part of the Program in Course Redesign, IUPUI redesigned its Introduction to Sociology course to encourage greater collaboration among students, increase student learning, and improve student success rates. Fulfilling requirements for students in several IUPUI schools, Introduction to Sociology enrolls approximately 2,000 students each year. In Fall 1998, 13 sections of the course were offered—two with 200 students each and 11 with 35–45 students each. The course redesign involved eliminating the multiple section course format where each class was developed individually by instructors and substituting a common format that included online learning modules, threaded discussions, interactive computer-based testing, and an interactive research module.

The Traditional Course

Introduction to Sociology was historically taught in a traditional format by faculty and teaching assistants. Students took examinations, wrote papers, participated in class discussions, and completed additional assignments that varied by instructor. There was no common textbook. Some instructors embedded a large technology component in their teaching, while others used virtually no technology. Research methods were taught differently in every section. In large sections, examination questions were objective and standardized, and required papers were of limited length and depth. A teaching assistant helped prepare, proctor, and grade exams. Small sections required more writing. Overall, sections were taught independently, with no coordination of content or approach among the faculty.

Two significant academic problems needed to be addressed in the redesign. The traditional course experienced a high DFW rate (the percentage of students receiving a D or F or withdrawing from the course) of 39 percent. The traditional lecture-and-testing format did not offer students the opportunity to learn collaboratively from one another or interactively from practice tests. A second problem was the lack of coordination among sections. There was no pooling of resource material and no standard expectation for collaborative learning.

The Redesigned Course

The prime objective of the redesign was to increase students' learning. Collaborative learning theory suggests that the more often students are able to engage in extended discussion about the course material, the more likely they are to learn it. IUPUI's new approach to teaching Introduction to Sociology was expected to motivate students to participate more fully in a collaborative learning environment and to help instructors be more efficient and effective in their roles as course facilitators.

The learning goals for the redesigned course required students to:

- understand basic concepts of sociology (e.g., understand and take a sociological perspective on personal experiences and public issues, recognize the limitations of individual experience, develop an awareness of the complexity of human social behavior, develop sensitivity to social and cultural influences on human activities and world-views, learn to think critically);
- learn how to work collaboratively in a computer-based environment; and
- understand basic concepts of composition as applied to writing for sociology.

To achieve these learning goals, the course introduced collaborative computer work in a research module common to all sections, with a special focus on the collection and analysis of data. The research module provided students with several opportunities to work independently and collaboratively on their writing and analytical skills. An online student social survey was used to introduce—and help students relate to—specific course topics as well as survey design and implementation. The survey provided data for students' presentations and papers. Comparing data gathered from students within the course with national survey data offered students a learning experience rooted in their own lives. Each of these learning resources offered instructors an opportunity to challenge students to think critically.

A common course management system developed at IUPUI called Oncourse was used to allow faculty to easily develop, distribute, and manage course material. Using Oncourse enabled faculty to effectively monitor students' progress and participation via access to statistics on students' use of the course Web site, allowing

early intervention in problem situations. The software also created a common discussion space that allowed all students (resident and commuter, traditional and nontraditional) to work collaboratively without location and time restrictions. Faculty members created groups in which students could easily contact one another. A traditional problem with classroom-based groups on IUPUI's urban campus is that students have trouble meeting with each other. Oncourse allows 24/7 group communication. Increasing the ease and amount of communication is especially important in large sections where instructor-student and student-student interaction is often inhibited by class size.

Interactive testing was also introduced. Quiz questions were available from a test bank, and at least one common, standardized examination was offered. In large sections, all examinations were delivered interactively; students were allowed to take these exams outside of class, which freed in-class time for additional student-faculty interaction and increased the potential for the assessment of students' learning.

Finally, some sections of Introduction to Sociology were linked to Elementary Composition (which is required of virtually all students on campus) in order to strengthen students' understanding and skill in writing about sociology. Linking these two courses provided a more substantive topical component for writers in Elementary Composition and provided better writing instruction in Introduction to Sociology.

Improved Learning

The IUPUI team conducted two types of assessments, both of which compared traditional sociology sections to redesigned sections. Comparisons were made in two areas: grades (especially the DFW rate) and performance on a test of key sociological concepts administered at the end of the semester.

In Fall 1998, before any course redesign, the overall DFW rate (the percentage of students receiving a D or F or withdrawing from the course) in Introduction to Sociology was 39 percent. In the Fall 2000 pilot, the overall DFW rate was 33 percent; in Spring 2001, it was 30 percent; in Fall 2001, it dropped to 25 percent. Results of a regression analysis that controlled for a range of student background characteristics confirmed that students in the redesigned format were significantly less likely (.01 level) than were students in traditional sections to earn a D, an F, or a W.

For a consideration of whether differences in the characteristics of students taking the course in the two formats might have been responsible for these results, final course grades were regressed on the following: whether or not the student was in a redesigned course; status (full vs. part-time); high-school percentile rank; total SAT

score; race; gender; whether or not the student was taught by a full-time or part-time faculty member; and whether or not the student was a beginning freshman. In Fall 2000, students in redesigned sections had higher (.10 level) grades, controlling for the other variables. Being a student in a redesigned section added about one-third of a letter grade (.33 on a 4.0 scale) to the student's final grade. In Spring 2001, a similar regression showed that students in redesign sections had significantly higher (.05 level) grades than those in the traditional format.

A set of common objective questions measuring understanding of key sociological concepts was developed and administered across all sections of Introduction to Sociology. In Fall 2000, when traditional sections were compared to redesigned sections in terms of the number of the 25 common questions answered correctly, a difference-of-means test showed that students in redesigned sections scored significantly higher (.05 level) than those in traditional sections. In Spring and Fall 2001, means for students' scores in the redesigned sections were not significantly different from traditional section means.

Both linked and non-linked sections were part of the course redesign. Linked sections were redesigned sections whose students were simultaneously enrolled in the same section of Elementary Composition. Non-linked sections were composed of students who were in a redesigned Introduction to Sociology section but who did not share a common section of Elementary Composition. Linked composition sections focused, in part, on sociological readings and concepts. One of the outcomes most positively affected by linking sociology and composition sections was improved student research paper writing in Introduction to Sociology. Impressionistic data from instructors indicates that students in linked sections write better in Elementary Composition than students in either traditional or redesigned, non-linked sections.

Reduced Costs

In Fall 1998, IUPUI offered Introduction to Sociology in two formats: large sections of 200 students and small sections of 35–45 students. Because the computer-based environment enabled greater interaction among faculty and students within a large course environment, IUPUI planned to reduce costs focused on increasing the number of large sections offered from two to three and decreasing the number of small sections. This change reduced the cost-per-student by 20 percent, for an annual savings of approximately $34,000.

Using Oncourse, which automates many features of course management, was the key element that enabled IUPUI to offer more large sections. Oncourse includes an online grade book feature that permits easy storage and calculation of grades. Since Oncourse allows the easy transportation of syllabi, assignments, and examinations from one semester to the next, preparation time from semester to semester, and

within semesters, is reduced. Oncourse allows instructors to send messages 24/7; thus, changes in syllabi and special notices concerning class, for example, can be delivered efficiently at any time. Oncourse also reduces the time that teaching assistants in the large sections of Introduction to Sociology must spend in recording grades and photocopying course materials. By implementing online examinations using Oncourse, faculty members were able to free up between one and four class periods per semester to allow additional instruction in areas not normally covered in class, more in-depth coverage of topics, and more time for students' group presentations.

In addition, IUPUI decreased the DFW rate from 38.9 percent in Fall 1998 (before redesign) to 24.8 percent (after redesign), translating to additional cost savings because fewer sections will be needed. Prior to redesign, 778 students needed to repeat the course; after redesign, that number dropped to 496. Since 282 students no longer needed to repeat the course, IUPUI could offer one fewer large section (of 200 students) at $6,199 and two fewer small sections (of 40 students each) at $6,671 each. The reduction in the DFW rate translates to an additional savings of $19,541, bringing the total cost reduction to $53,541 achieved by the redesign.

CASE STUDY 3: Portland State University

Portland State University (PSU) is Oregon's largest university, serving more than 20,000 students. Located in downtown Portland, the state's largest metropolitan area (population 1.4 million), PSU is also Oregon's most diverse higher education center. Similarly diverse is the Portland Public School District which serves students speaking over 60 languages. Interest in Spanish language instruction is broad and deep, ranging from Oregon's growing Hispanic population to business, industry and government.

As part of the Program in Course Redesign, PSU redesigned its First-Year Spanish sequence, a year-long, multiple-section course. Students earning a BA at PSU must complete the equivalent of two years of university-level language. Because of funding and space limitations, however, enrollment had been arbitrarily set at about 690 students annually. In some academic years, current offerings could meet only 50 percent of the demand, and students were forced to enroll at other institutions. The redesigned course allowed PSU to serve more students for approximately the same labor cost by reducing class meetings from three per week to two. Testing, writing and grammar instruction, and partner/group activities were moved outside the classroom using multimedia materials, leaving increased class time for interactive speaking.

The Traditional Course

When the redesign process began in July 2001, PSU's traditional First-Year Spanish course was in transition in order to articulate with Oregon's K–12 universal second language exit requirement. This new requirement had become an entrance standard for colleges, and moving to complementary mastery standards was part of the redesign. Pedagogy and basic materials (including a CD-ROM prepared by the PSU faculty) used in the traditional course were proficiency-oriented and practical. However, instruction, delivery of materials, staff training and supervision, and logistics (testing, grading) had not been modernized. In addition, there was significant inconsistency among sections.

The learning goals of the course were focused on acquiring basic language skills including speaking, listening, reading, and writing Spanish materials representing every-day situations. One senior faculty member coordinated the course content; selected, trained, and supervised the teaching assistants (TAs); and taught one section. TAs taught the 9–10 remaining sections with considerable variation in goals and teaching methods. The TAs lacked significant training and experience in language acquisition, and their instructional approach often mimicked older teaching practices focusing on language structure (grammar) rather than functional language acquisition, practice, and proficiency.

The DFW (drop-failure-withdrawal) rate was approximately 25 percent from fall to spring. This rate was related to two problems. The first was a wide variation in Spanish proficiency among students when they began the course. The range of skills required in the course can be intimidating and may exacerbate early drop and withdrawals. Second was the problem of "false beginners." False beginners are students who have some basic language skills and are able to demonstrate proficiency early in the course but not later, leading to drops and withdrawals.

The Redesigned Course

The learning goals for the redesigned First-Year Spanish course were to:

- increase student proficiency in spoken language using classroom, online, and collaborative learning;
- use online course components to increase student proficiency in language structure, writing, and reading;
- improve student cultural awareness through in-class and online learning; and
- provide immediate support to low-achieving students.

The redesigned course was designed to increase enrollments by one-third to one-half. It also addressed inconsistencies among sections through improved planning, standardized materials, ongoing assessment, and better coordination and training of teaching assistants. Finally, it provided clear articulation between the K–12 universal

second-language requirement in Oregon (on exit) and the Oregon University System (on entry) through specification of learning outcomes for the course.

To accomplish these goals, the redesigned course reduced class meeting times from three per week to two while increasing the time students spent in the crucial area of interactive speaking. Resistance to reduced seat time models in foreign language instruction stems partly from the perception by faculty, instructors, and students that seat time equals oral communication time when this is often not the case. Portland State's reduced seat time model moved mechanical and drilling activities that would otherwise be performed in class to the online environment while devoting in-class time to oral communication. Online activities included testing, writing and grammar instruction, as well as small group activities focused on oral communication. In-class time was further reduced for those students clearly performing above standards, while low-achieving students were directed to small group sessions for additional oral practice.

The PSU team used WebCT's chat function to extend class discussions beyond the classroom. Chat participation was graded using transcripts of the sessions. The exchanges prepared students for weekly discussion board activities, in which students summarized and presented the information they learned in the week's chat session. The discussion board allowed instructors to provide a model of good work. Students read the model before writing their own composition and frequently responded to feedback from the instructor. In both communication mediums, students performed well, staying in the target language and staying on task.

The primary instructional material used in the redesign was a multimedia version of the comprehensive proficiency-oriented introductory Spanish program ¿Cómo? produced at Portland State. The course coordinator developed all assignments, thus reducing preparation time for the TAs. TAs were trained more consistently and thoroughly with greater emphasis on conducting the oral proficiency interviews.

Improved Learning

PSU's assessment of learning outcomes measured student success against established national guidelines from the American Council of Teachers of Foreign Languages (ACTFL), including an Oral Proficiency Interview that has been widely validated, and against Oregon proficiency standards. This allowed the university to compare results of their redesign to baseline literature about results of traditional pedagogy; to compare the added effect of use of multimedia to the same material delivered conventionally; and to gauge the effect of new remediation strategies on students' performance. PSU has not completed its full assessment, but early results show improvements in student learning. A comparison of mean scores on an oral proficiency exam, the focus of First-Year Spanish, showed the redesign students outperformed traditional students. The mean score for the traditional group was 81.5

percent, whereas the mean score for the redesign group was 87.2 percent.

Other universities using similar redesign techniques have shown equally promising results. The University of Illinois at Urbana-Champaign (UIUC) pioneered the redesign of foreign language study using the reduced seat-time model using techniques similar to those used by PSU. By using instructional technology, UIUC can now teach almost twice as many students in their high-demand Spanish courses with the same staff, thus solving an historic academic bottleneck caused by the inability of the university to offer sufficient sections to meet student demand. Students in the technology-enhanced format made significantly greater gains in scores on a Spanish placement exam than did students in the conventional format.

The University of Tennessee, Knoxville (UTK) redesigned Intermediate Spanish Transition, an introductory language course enrolling more than 60 percent of entering students. As at PSU and UIUC, the traditional course structure was unable to provide enough sections to satisfy enrollment demands. The redesign substituted online diagnostic homework exercises (grammar, vocabulary, and graded workbook assignments) for one in-class period per week. Immediate feedback on all graded assignments was given via online assessments. These assessments provided immediate feedback to students on all graded assignments and eliminated the extremely time-consuming activity of grading homework exercises, quizzes, and examinations for instructors. Rather than dealing with skill-based practice in class, instructors had more time to emphasize active speaking skills and cultural awareness. Any-time access to course materials allowed more self-pacing for students, and immediate feedback on their progress assisted students in understanding their deficiencies.

Like PSU, UTK used ACTFL guidelines to test the oral proficiency skills of students. Students were also assessed using a Spanish placement examination developed by the university, as well as mid-term and final exams. Finally, students engaged in a Simulated Oral Proficiency Interview—a more complex measure of proficiency. On the Simulated Oral Proficiency Interview, redesign students performed significantly better than traditional students on six of eight dimensions of language proficiency. There were no significant differences in foreign language proficiency or achievement between the traditional and redesign groups on the post-tests, although the results for the redesign group were generally slightly higher. UTK's collective findings suggested that a reduced seat-time format can produce student outcomes better than or equivalent to a three-day format. The pedagogical changes in both the in-class and online components of the course worked in concert and compensated for reduced contact time.

Student satisfaction responses at PSU indicate greater satisfaction with the redesigned sections than the traditional ones. At the end of Fall 2002, students completed an evaluation survey that looked at student perceptions of the online

learning experience in relation to technology use, course content, perceptions of instructor, and peer interactions. When students were asked to compare their experience of online learning to that of a traditional face-to-face course, students consistently reported a better or richer learning experience in all categories, including receiving individualized attention and more timely feedback from the instructor; spending more time studying and reviewing; interacting with fellow students on course-related work; being able to communicate a complaint or suggestion to the instructor, to learn and master course material, and to keep up with the required work; and feeling more connected with the instructor and with other students.

Cost Savings

Portland State used technology to nearly double the number of students taking Spanish (from 690 to 1,276 students) without a commensurate increase in instructional costs. The increase was achieved by increasing the number of sections offered while keeping section sizes small because of the emphasis on oral proficiency during in-class time. TA responsibilities and hours shifted from time spent on course preparation to increased time spent on delivery. The interaction among TAs and students increased annually from 180 hours in the traditional format to 1,125 hours in the redesign. Overall TA time increased from 3,240 hours in the traditional course to 4,499 in the redesign; faculty time remained unchanged. While the labor costs increased slightly, the student enrollments increased substantially, yielding a reduction in the cost per student from $178 to $127. The overall cost will increase from $123,125 for 690 students in the traditional course to $162,023 for 1,276 students in the redesigned course.

UTK took a different approach to section size. In the traditional format, the university offered 57 sections of 27 students each annually. In the redesign, experienced instructors were paired with TAs, and section size was doubled from 27 to 54 students, thus reducing the number of sections needed from 57 in the traditional format to 38 in the redesign. The traditional course enrolled about 1,500 students; in the redesign, about 500 more students were able to be served for a total enrollment of 2,052. In the traditional model, the faculty spent a significant amount of time evaluating student work. In the redesign, grading time dramatically decreased from 141 hours to nine hours per section per term. Overall instructor time spent on the course decreased from 276 hours to 96 per section, thus decreasing the cost-per-student from $109 to $28, a reduction of 74 percent. Savings have been reinvested in the course and used to redesign other language courses.

The most readily transferable and the most labor-efficient aspects of the products used in the redesign were those that focus on automation. Any course (not just foreign language courses) already using mechanical grading or requiring instructors to grade mechanics can greatly benefit from a similar redesign. For Spanish, there is

a wealth of online materials and WebCT materials on the market. The WebCT content for the *¿Cómo?* text will be available soon after PSU's 2002–2003 full implementation of the redesigned course. While allowing automation of some course components, the online environment maintains the instructor's ability to supervise student work and assure compliance with course requirements. In this sense, the online version of the course is considerably more adaptive than using stand-alone media materials.

CASE STUDY 4: University of Central Florida

The University of Central Florida (UCF), located in Orlando, Florida, was established in 1963 and opened in Fall 1968. Enrollment at UCF has grown from 1,948 students in 1968 to 38,795 in Fall 2002. The university was initially developed in response to the Cape Kennedy space complex, but with time the university acquired a broader educational mission. UCF's present role within the ten-university State University System of Florida is that of a general purpose institution offering degree programs at all levels of instruction. In addition, the university assists in the economic development of the Central Florida region, especially in the areas of high technology, electronics, and tourism.

As part of the Program in Course Redesign, UCF redesigned its American National Government course to improve student performance and retention and to reduce the need for classroom space. American National Government is an introductory-level course, one of two options that fulfills UCF's general education Social Foundations requirement and the option that 75 percent of students choose. The course enrolls approximately 2,200 students annually in 30 sections of 80–100 students each. Students in any given section of the course represent varied majors, levels of interest, and exposure to the subject at the high school level. The course redesign involved substituting Web-based, asynchronous, modular learning for two-thirds of the in-class time and creating small collaborative learning groups within this online structure.

The Traditional Course

The traditional version of American National Government was taught primarily by full-time faculty in a lecture (three 1-hour or two 1.5-hour periods per week) and test format, supported by graduate teaching assistants (GTAs) who assisted with exams and grading. In some sections, faculty incorporated Web-based materials as a classroom supplement. Instructor-student and student-student interaction was consistent with that of a large lecture course. Although data collected on traditional lecture sections during Fall 1998 showed a success rate (a grade of C or better) of 78 percent, the number of students who needed to retake the course was more than 100 per year.

Two specific problems needed to be addressed in the redesign. Retention in this course and in other large-enrollment general education courses needed to be improved. UCF had experienced increased success rates (85 percent) for students in sections that are partially Web-based in comparison with the success rates (78 percent) of traditional lecture sections. UCF expected to see a higher success rate in American National Government after the course was redesigned, thereby reducing—by at least one—the number of sections needed for repeat students.

In addition, the course required too much in-class lecture time in a campus environment with scarce space for large lectures. UCF's dynamic growth has created a shortage of classroom space (currently more than 40 percent). Overall, UCF currently pays $1.8 million annually for rented classroom space. The cost of classroom space for a traditional 100-student section of this course was $1,189.

The Redesigned Course

UCF's redesign of American National Government substituted Web-based, asynchronous, modular learning for 67 percent of the lecture time, thereby reducing the number of lectures per week from three to one. Course redesign not only enhanced the learning experience and increased the success rate for students but also addressed the very real space-related cost problems faced by the university.

The learning goals for the redesigned course required students to:

- understand the three major topics of the course (founding principles and the Constitution, institutions, and mass politics);
- show critical and analytical thinking skills and conceptual understanding of the material;
- be aware of the skills and values essential for the healthy functioning of democratic principles; and
- more actively participate in activities that facilitate student-centered learning.

To achieve these learning goals, the course replaced classroom time with interactive Web-based modules that increased students' interaction with course content, other students, and the instructor. The modules were designed to motivate students to become active learners and to encourage critical thinking and analysis. Examples of course activities include self-paced, auto-graded quizzes and games with instant feedback; interactive, Web-based election simulations; and test banks to review and prepare for exams. Web-based teaching methods, tools, and learner activities made the course learner-centered and contributed to the development of a community of learners.

The modules used existing, stable Web sites, many of which are administered by state or national governments, to provide dynamic course content. A substantial

amount of subject-related information is available on the Web. Students were introduced to relevant Web sites through assignments. Students completed an analysis of the material by dissecting the argument, by providing questions that lead to a critical analysis or synthesis of the information, or by stimulating a critical discussion of the topic. Students were also required to summarize their findings and analysis in short papers. Usually, these assignments asked students to link concepts covered in class to concrete examples; thus, the assignments reinforced both concepts and their application. On interactive Web sites, students provided information and received immediate feedback, for example, in simulations of elections or public opinion quizzes. Similarly, when students took online tests and quizzes, they received an instant grade, which reinforced what they were learning.

Communications software, bulletin boards, or chat rooms provided useful and convenient opportunities to increase discussion between and among students. To promote collaborative learning, instructors divided students into groups of approximately 10 students each for activities with discussion components, thereby creating a small-class atmosphere within a large-class setting. The membership remained constant throughout the semester; students thus were able to benefit from the informal learning communities that were created. Examples of group activities include role-plays, simulations, case studies, and collaborative writing and peer review of research and writing projects. Within this environment, faculty and GTAs provided mentoring and tutorial support for technology-challenged students.

Students in large lecture classes tend to be passive recipients of information, but in discussion forums, students participate actively. According to existing research evaluating participation patterns in discussion forums, more students post messages than participate regularly in classroom discussions. Additional research suggests that messaging is fairly evenly distributed among students. Shy students frequently feel less inhibited in computer-mediated discussions. In addition, course management software allows the instructor to monitor the frequency and the quality of students' contributions to the discussions more easily and carefully than in a crowded classroom, and thus to assign grades with less difficulty.

Improved Learning

To compare the outcomes of the redesigned course with those delivered in the traditional format, the UCF team administered a content examination on knowledge of American government to students in both course formats. The exam was based on an 18-point, fact-based scale. Students enrolled in the redesigned sections showed significantly better pre-test and post-test improvements in content knowledge on this instrument as well as significantly better absolute post-test performances. The assessment data presented below are derived from four pilot sections at 50 percent reduced seat time in Fall 2000 and three sections at 50 percent reduced seat time in Spring 2001.

Format	Post-Survey Mean	Pre-Survey Mean	Mean Change
Traditional (N=52)	10.7	9.1	+1.6
Redesign (N=37)	11.3	8.4	+2.9
Total (N=89)	11.0	8.8	+2.2

Increases in political knowledge scores were evident across the board. Ignoring format differences, students averaged a 2.2 mean increase on the 18-item index. Yet the traditional students and redesign students showed notable differences in this regard. Whereas the students in the traditional-lecture format posted a 1.6-point mean improvement, the mean change for students in the redesigned course, at 2.9, was almost double that amount. As noted below, the students in the redesign were somewhat less motivated, making their learning gains even more significant.

When compared with their traditional counterparts, the students who selected the redesigned course had less academic experience, less previous exposure to Web-based courses, and lower levels of motivation to learn about American politics. From a methodological standpoint, these motivational and attitudinal differences suggest a conservative test for the effects of the redesign format on student outcomes. From a pedagogical standpoint, however, this result suggests that a less-prepared student audience is, at least initially, selecting environments using this new form of instruction.

Students enrolled in the redesigned sections evinced greater levels of satisfaction, particularly in areas involving student-student interaction. A pre- and post-questionnaire revealed that students evaluated the redesigned format more favorably in the helpfulness of discussions with other students, ease of contact with the instructor, and opportunities for expressing and sharing ideas. Though students' assessments of the ease or difficulty in following and completing assignments were the same in both formats, students in the redesigned sections found course assignments to have much greater benefit for understanding course content. This large difference suggests that a key theoretical advantage of Web-enhanced instruction—bringing active learning to bear on course content—paid considerable empirical dividends. Additionally, students enrolled in the redesigned course expressed greater willingness to take another political science course employing the same format.

Reduced Costs

There was no change in the absolute amount of time spent on the course by either faculty members or GTAs, but the kinds of activities in which they engaged changed considerably. Because there were fewer lectures, faculty members spent less time preparing and presenting material and more time interacting with students, designing assignments, and diagnosing and monitoring students' progress. The

GTAs spent more time selecting software and preparing tests and less time evaluating tests. Both shifts involved more interaction with students and their work.

UCF's plan to reduce costs focused on saving funds spent for renting the classroom space needed to accommodate a rapidly growing student population. At $22 per square foot, the cost to rent a 100-seat classroom is $44,000 annually. Based on UCF's scheduling policies and procedures, 37 traditional class sections can be placed in a single classroom annually. Therefore, the cost to rent a 100-seat classroom for each traditional section is $1,189 if the classroom is utilized to capacity.

The total cost for each section of American National Government in its traditional format, including personnel and classroom space rental, was $8,239. By reducing live-class meeting time by 67 percent, UCF reduced the cost to rent a 100-seat classroom to $396 for each redesigned section. A single classroom can hold 111 redesigned class sections annually. The total cost for each redesigned section, including personnel and classroom space rental, was reduced to $7,446.

Due to the more efficient use of 100-seat classrooms in the redesigned course configuration, five fewer sections were needed to accommodate the same number of students each year, amounting to savings of $46,309, including faculty, GTAs, and traditional classroom rental costs. UCF data collected in earlier redesigned courses showed a 7 percent increase in retention rate in redesigned class sections. Applying this increased retention rate to 25 redesigned American National Government sections results in a one-course-section reduction, amounting to an additional $8,239 cost savings. In addition, $19,825 in classroom space rental cost would be saved because of the reduced per-section rate for the redesigned sections.

The total cost for the traditional American National Government course was $247,170. When the redesign is implemented in all 24 sections, the total cost for the course will be reduced to $178,704, producing an annual savings of $68,466. These savings will continue each year that the new course-delivery model is used. When the redesign techniques are applied to other high-enrollment courses, the cost savings become significant. Applying the projected annual savings to 15 other high-enrollment courses would amount to $1,026,990.

At UCF, the Mathematics Department is adopting the reduced-seat-time model for its College Algebra course, and the English Department is using it in Composition I and II. These courses are part of a large-enrollment general education program that affects almost all freshmen and sophomores, thereby adding to the cost savings. Since the inception of the reduced-seat-time course model, institutional dependence on off-campus classroom space has diminished. In the late 1990s, between 65 and 70 traditional course sections were housed in rented space in a nearby high school each academic year. In 2000–2001, that number dropped to 50. In 2001–2002, only

33 course sections were offered at that location. UCF also ended its rental of seven movie theaters as 100-seat lecture halls last year. This reduction coincides with the following data: the number of sections of reduced-seat-time courses offered each term doubled in Spring 2002, from an average of 50 to 103. Enrollments also nearly doubled, from 2,114 in Fall 2001 to 4,115 in Spring 2002.

CASE STUDY 5: University of New Mexico

Located in the heart of Albuquerque, New Mexico, The University of New Mexico (UNM) is a large urban commuter institution serving approximately 25,000 students, 16,000 of which are undergraduates. UNM is one of only three Hispanic-Serving Carnegie Doctoral/Research-Extensive universities in the nation. With an undergraduate minority student population of approximately 46.4 percent (31.3 percent Hispanic, 5.5 percent Native American and 9.6 percent other), UNM leads the nation's research universities in student diversity. UNM students are primarily commuters who also work 30 or more hours per week.

As part of the Program in Course Redesign, UNM redesigned its General Psychology course, its largest and most popular undergraduate "killer" course. Fulfilling the social and behavioral sciences requirement for the undergraduate core curriculum, General Psychology enrolls 2,250 students annually. The course redesign reduced the number of lectures each week, incorporated a weekly 50-minute studio session, and supplemented these activities with interactive Internet/CD-ROM activities, quizzes, and programmed self-instruction offered on a 24/7 schedule. Students were required to take repeatable quizzes each week requiring a C-level of mastery. An active intervention strategy ensured that students were making progress.

The Traditional Course

Prior to its redesign, General Psychology was taught in a traditional lecture format with no recitation sections. Four full-time tenure track faculty assisted by one graduate assistant per section each taught one large lecture section (450–600 students) annually. Five graduate student instructors taught five additional sections (25–150 students) of the course per year in the evenings, on weekends, and in the summer.

UNM's primary redesign goal was to improve the course's extraordinarily high 42 percent drop-failure-withdrawal (DWF) rate, 30 percent of which were failures and a disproportionate number of which were minority students. UNM has one of the lowest student retention rates among public research universities. High failure rates in core curriculum courses such as General Psychology are known to have a strong negative impact on UNM's low overall retention and graduation rates.

The learning objectives for General Psychology required students to:

- learn factual knowledge and a conceptual understanding of important behavior principles, theories, and applications;
- understand principles of scientific and critical thinking; and
- benefit from using this information as a frame of reference in their own lives.

The Redesigned Course

The course redesign had five primary goals:

- increase student success through greater understanding and retention of course content through learner-centered, technology-based learning opportunities;
- decrease course failure rates by providing frequent feedback to students and instructors, increasing student contact with upper level peer leaders to facilitate learning, and employing an active intervention strategy to monitor ongoing student progress;
- provide consistency across sections using online resources;
- reduce costs associated with teaching the course; and
- increase institutional student retention rates by increasing student success.

The redesigned course reduced the number of lectures each week from three to two and incorporated a weekly 50-minute studio session led by undergraduate teaching assistants (UGTAs). Drawn from students who had shown a 90 percent or better mastery of the material in previous sections of General Psychology or who were upper-division honors students, UGTAs received weekly training on the topics for that week. These in-class activities were supplemented by interactive Web- or CD-ROM-based activities and quizzes, offered on a 24/7 schedule. Students were able to interact online with other students and review concepts based on individual need and self-scheduled pacing. The online components utilized commercially available software which contained interactive activities, simulations, and movies, including *Multimedia Psychology* available from Prentice Hall and *Interactive Psychology* and *PowerPsych* published by Harcourt, Inc. Students took repeatable quizzes each week requiring a C-level of mastery.

The asynchronous learning environment also included programmed self-instruction (PSI), a learning technique that provides the individual student a self-paced method of learning new information. Using a branching sequence of interconnected questions, PSI includes repetition, examples, illustrations, and anecdotes to convey important psychology concepts. An active intervention strategy ensured that students were making progress. Graduate teaching assistants monitored quiz performance, contacting and counseling students who failed to achieve a C-level of performance as to how to improve.

Improved Learning

UNM's goal of reducing drop and failure rates in General Psychology has been achieved. The failure rate was reduced from previous levels of 30 percent to 12 percent, and the DWF rate fell from 42 percent to 18 percent. The number of students who received a C or higher rose from 60 percent to 76.5 percent, and there were more A (34 percent) and B (31 percent) grades than recorded in previous semesters. At the same time, the course was arguably more difficult, requiring students to completely cover a high-level introductory text. Instructors in previous semesters sometimes omitted chapters from the course because they were unable to cover all of the text material.

What contributed most to improved student performance? The UNM team believes that the major determinant was the required mastery quizzes. For all quizzes, only highest scores counted. Students were encouraged to take them as many times as necessary in order to receive a high score and to gain a sense of mastery over the material. Additionally, they were told that questions on the four in-class exams, worth 50 percent of their grade, would be taken from mastery-quiz items. The more often they repeated quizzes, the more likely their chances of seeing actual exam questions.

Students received credit for completing two online mastery quizzes per week for 16 weeks, which represented 25 percent of their grade. Each quiz consisted of 10–20 randomized multiple-choice questions drawn from a pool of 150–200 test bank questions provided by the course textbook publisher, Wadsworth-Thomson; the total pool consisted of approximately 3,000 questions for the semester. An additional 20 percent of their grade was determined by performance on 10 additional quizzes compiled from the self-paced interactive CD-ROM set that accompanied the textbook, representing another pool of 550 questions. Quizzes were delivered and graded automatically on a 24/7 schedule using WebCT.

Evaluation of quiz-taking behavior indicated that the more times students spent taking quizzes (in terms of elapsed time per quiz as well as number of quiz attempts), and the higher their scores (highest and average scores), the better they performed on in-class exams. Students who received grades of C or better took the quizzes on average four to six times. Some students developed strategies to increase exam performance. They would continue taking quizzes even after they had attained perfect scores because doing so would increase their chances of seeing items that might appear on the next exam.

Quizzes closed on a weekly basis corresponding to that week's topic. If students missed a quiz deadline, make-up quizzes, which were identical to the original quizzes, were always available online. To encourage students to take quizzes in a timely manner, however, make-up quizzes counted only 75 percent of the original

quizzes. During the last three weeks of the semester, students were allowed to take "amnesty" quizzes, which were identical to the original quizzes and for which students received full credit for completing.

UNM implemented a quasi-experimental design for two Spring 2002 sections (350–450 students each) so that all students would have access to all components of the redesigned course. Although students in both sections had access to the same instructor, text, CD-ROM, and curriculum, only students in the redesigned section were required to complete all aspects of the course. To determine whether quizzes that were mandatory (required for course credit) or voluntary (no course credit) would differentially affect exam and grade performance, students in one section received course points for completion of weekly online mastery quizzes. Students in the other section were encouraged to take the mastery quizzes (and were told that taking the quizzes would improve their grades), but received no course points for doing so.

On in-class exams, students in the section that were required to complete quizzes for credit always outperformed students in the section where taking quizzes was voluntary. Students in the redesigned section received more As, Bs, and Cs, in addition to fewer C- or below grades, than students in the voluntary quiz section. Students took more quizzes, scored higher, and spent longer on quizzes when course credit was at stake than students in the section where quizzes were not linked to credit. Moreover, relatively few students successfully completed quizzes when credit was not a consequence, and some students chose not to take quizzes at all.

Contingent upon their in-class exam performance, students were required to attend studios that focused on improving their learning skills and which provided a structured review of multimedia CD-ROM activities. Performance at 75 percent or lower on the first of five in-class exams, which yielded 38 percent of the class, was used to determine which students would be required to attend the mandatory weekly studios (any student, however, could attend). UGTAs encouraged students to work together on completing CD-ROM modules, and they promoted the use of various learning strategies. Although the studios provided an opportunity for student interaction, studio UGTAs reported limited success in fostering much interaction. Students sometimes commented that they could have spent their time more profitably by working with the CD-ROM at home.

Students who performed below C could often be characterized by one or more of the following: (1) lacking learning skills, (2) lacking motivation, or (3) having other priorities. All students in studios received peer-led coaching designed to help them better memorize key terms and concepts. To improve motivation and perhaps affect prioritization decisions, students in half of the studios received motivational interviewing (MI), a non-confrontational style of interacting, which has been used successfully in a number of behavioral interventions, including addictions. Students

in the other half received standard prescriptive advice. A third group was comprised of students who were required to attend but chose not to. Compared to the third group, the other groups performed better on exams and quizzes, although preliminary analyses revealed no differences between the MI and directive groups.

Reduced Costs

In the redesigned course, the two large sections were combined into one large section of 750 each semester. The smaller sections offered in the evening and weekends were expanded from 75 students to 200 per section. The number of sections offered annually was reduced from nine to seven, releasing two full-time faculty members from teaching sections of the introductory course and allowing them to teach other courses.

The redesign produced substantial cost savings, reducing the cost-per-student from $72 to $38, a 47 percent decrease. Reductions in instructor time devoted to lecture presentation and delivery represent the source of greatest savings from the redesign. Expensive faculty time was reduced from 1,056 hours to 220 hours per year; TA/GA time from 2,880 hours to 1,960 hours per year; and professional/staff time from 90 hours to eight hours per year. Overall, annual course delivery costs decreased from $161,184 to $85,012, producing an annual cost savings of $76,142.

E-mail allowed the UNM team to respond to thousands of student problems, which at the beginning of the semester usually focused on technology-related issues (e.g., can't log in, can't save quiz data). While the nature of the e-mail changed as the semester progressed, it was uncommon for students to e-mail questions regarding content issues. (Another course redesign project in mathematics at Rio Salado College corroborates this finding. Approximately 90 percent of student questions e-mailed to course instructors were unrelated to course content.) Most students were able to master the basic technological requirements within a few weeks, but this reduction in volume was replaced by students requesting make-up quizzes and the like. Most e-mail is now answered by TAs, and more emphasis is placed on FAQ listings.

UNM plans to use the redesign of General Psychology as a model for the redesign of other high-demand, large-enrollment, undergraduate core courses such as Introductory Spanish and General Biology.

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