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Best Practices for Integrating Technology into the Classroom

In this report, The Hanover Research Council provides guidance on the integration of cutting-edge technology into post-secondary classrooms. Drawing upon secondary research by leading professional organizations, we provide a discussion of frameworks for technology integration, illustrated by numerous empirical examples of successful case studies. We conclude with a review of key advantages and impacts of technological integration in higher education.

Introduction

The use of technology in education has transformed instructional methods and students' learning processes. For example, The Center for Applied Research in Educational Technology (CARET) has suggested that the use of technology in the classroom has a positive impact on students' academic performance. Among CARET's main findings, the organization concludes that technology improves students' performance when its application:[1]

- Directly supports curriculum objectives
- Provides opportunities for student collaboration
- Adjusts for students' skill ability, and provides responsive feedback to the student (and the instructor) about his or her progress
- Is integrated into everyday instruction
- Provides opportunities for students to design and carry out projects

Given these guidelines, the benefits of incorporating technology into the post-secondary classroom are manifold. The George Lucas Educational Foundation, for example, contends that promoting the use of technology in the classroom contributes to the development of students' 21st century skills, such as: personal and social responsibility, strong communication skills, and visualization and decision-making skills.[2] The Foundation further suggests that technology engages students in the learning process, promoting "higher-order thinking, analysis, and problem solving." To this effect, the integration of technology in education has significant repercussions in supporting students' achievement towards learning objectives:[3]

> Effective tech integration must happen across the curriculum in ways that research shows deepen and enhance the learning process. In particular, it must support four key components of learning: active engagement, participation in groups, frequent interaction and feedback, and connection to real-world experts. Effective technology integration is achieved when the use of technology is routine and transparent and when technology supports curricular goals.

Comprised of a wide array of multidimensional tools, the use of technology has a particular meaning in the context of education. Educause, a non-profit association that promotes the use of information technology in higher education, notes that instructional technologies "are not single technologies but complex combinations of

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[1] The Center for Applied Research in Educational Technology. "Topic: Student Learning." http://caret.iste.org/index.cfm?fuseaction=answers&QuestionID=1
[2] Edutopia. "Why do we need technology integration?" http://www.edutopia.org/teaching-module-technology-integration-why
[3] Edutopia. (March 16, 2008). "Why Integrate Technology into the Curriculum?: The Reasons Are Many." http://www.edutopia.org/technology-integration-introduction

hardware and software that support teaching and learning activities."[4] Popular instructional technologies may include, but are by no means limited to: course management systems, content management, curricular software, digital video, electronic portfolios, electronic whiteboards, games and gaming, instructional and learning management systems, multimedia applications, social software, student/classroom response systems, and videoconferencing.[5] Given the vast array of technological tools used in the classroom, in this report we focus our analysis on interactive learning strategies, such as: online learning activities; Web-based, multimedia resources; and commercial software.

Based upon our review of secondary research on best practices for integrating technology into the classroom, we provide guidelines for higher education institutions seeking to adopt cutting-edge technological tools as part of their curriculum. With this objective in mind, the report proceeds as follows. We begin with a discussion of five models for technological integration as outlined by the National Center for Academic Transformation (NCAT). Within this overview, we explore numerous examples and case studies of higher education institutions that have successfully incorporated technology into their curriculum. We also provide a synopsis of best practices and general guidelines for integrating technology in post-secondary classrooms. In the next section, we investigate special issues and challenges for integrating technology into foundation or lower-level courses, as suggested by two in-depth case studies. We conclude with an overview of key advantages of integrating technology into higher education learning, including: practice-based classrooms, individualized learning assessments, and cost reduction.

[4] Educause. "Instructional technologies – 601 Resources."
http://www.educause.edu/Resources/Browse/InstructionalTechnologies/25452
[5] Ibid.

Models for the Integration of Classroom Technology

Since the late 1990s, the National Center for Academic Transformation (NCAT) has conducted a wealth of research on academic transformation, defined as "an approach that seeks to increase student learning outcomes and contain costs by focusing on the redesign of large introductory university courses." Technology is used as the primary tool to "refashion the course activities"[6] and increase the amount of active engagement students have with the course materials.

NCAT identifies five combinations of traditional and technology-based instructional methods which are defined by how they use each component. The strategies are arranged on a continuum from the most traditional to the most technologically-centered models, and have gained industry-wide acceptance as a means of differentiating between instructional programs. We have provided the NCAT's terms for these strategies, along with their definitions, below.[7]

- **The Supplemental Model** retains the basic structure of the traditional course and a) supplements lectures and textbooks with technology-based, out-of-class activities, or b) changes what goes on in the classroom by creating an active learning environment within a large lecture hall setting.

- **The Hybrid Model** reduces the number of in-class meetings and a) replaces some in-class time with out-of-class, online, interactive learning activities, or b) also makes significant changes to remaining in-class meetings.

- **The Emporium Model** eliminates all class meetings and replaces them with a learning resource center featuring online materials and on-demand personalized assistance, using either a) an open attendance model or b) a required attendance model depending on student motivation and experience levels.

- **The Fully Online Model** eliminates all in-class meetings and moves all learning experiences online, using Web-based, multi-media resources, commercial software, automatically evaluated assessments with guided feedback, and alternative staffing models.

- **The Buffet Model** customizes the learning environment for each student based on background, learning preference, and academic/professional

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[6] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 1. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)

[7] See: "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)

goals, and offers students an assortment of individualized paths to reach the same learning outcomes.

As closer inspection reveals, each strategy uses human and technological resources in vastly different ways. For example, some models are far better at maximizing the effectiveness of instructors and teaching assistants in combination with technology-centered activities, while other methods retain the instructor's traditional role as a lecturer and treat instructional technologies as replacements for more traditional techniques like class discussion and paper-based assignments.

With these characteristics in mind, this section will examine the five NCAT course transformation strategies introduced above in greater detail. Understanding how each model works will allow us to explore how each one has been applied to meet specific needs, such as improving student outcomes and reducing the cost of instruction. In addition, a closer investigation of each method reveals how the different models utilize cutting-edge technology most effectively.

Along these lines, our discussion of each course redesign model is accompanied by several examples describing how that model looks in practice. These examples derive in large part from a major study of academic transformation – *Program in Course Redesign (PCR)* - conducted in the early 2000s by NCAT and the Pew Charitable Trusts, which awarded $8.8 million to fund course redesign programs at 30 universities and community colleges from 1999-2004.[8] NCAT helped to implement each project and analyzed the results.

The Supplement Model

Of the five NCAT models, the supplemental model most closely resembles the traditional, classroom-centered course model. In the supplemental model, online or other technology-centered activities allow students to put lecture and reading materials into practice outside of the classroom. Technology may also be employed during class time for the purpose of reinforcing and applying the day's lesson, but supplemental courses still meet face-to-face as often as traditional classes. The major difference between traditional and redesigned courses stems from the latter's use of instructional technology to replace large-scale lectures, discussions, and demonstrations with collaborative or independent practice activities meant to maximize the amount of contact students have with the materials.[9]

NCAT gives several examples of how the supplemental method can contribute to a traditional course, with or without changing what is actually done in class. Activities can be as simple as incorporating an online program or a textbook's accompanying

[8] "Who We Are." The National Center for Academic Transformation. 2005. (http://www.thencat.org/whoweare.html)

[9] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 1. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)

materials into homework or laboratory assignments. As an example, General Psychology students at the University of New Mexico "use a two-disc CD-ROM—which contains interactive activities, simulations, and movies—to review and augment text material." They must complete four online quizzes on the additional material each week to ensure their continuous engagement with it.[10] Similarly, Carnegie Melon University uses "an intelligent tutoring system" to coach its students through computer-based lab assignments in its Introductory Statistics course.[11]

In cases where supplemental materials are included in formal class time they may also be used outside of class as well. The University of Massachusetts-Amherst incorporates a commercially-available technology into its homework assignments in General Biology, but also uses the same software in the classroom. Classes are typically lecture-based, with frequent breaks in which students practice the concepts that have just been introduced using the software program.[12]

A second example of supplemental technology altering the format of a traditional course comes from the University of Colorado-Boulder.[13] The university offers a lecture-based Astronomy class that enrolls up to 200 students per session. The entire class meets two times a week. The first of these meetings is largely lecture-based and permits the instructor to introduce the week's materials. The instructor then posts pertinent questions online and before the class's second meeting the students organize themselves into groups of 10 to 15 to answer the questions collaboratively. The small groups are led by undergraduate instructional assistants and required to post their responses on the course's online discussion board. Before the second class meeting, the instructor examines each group's response and facilitates a large-scale discussion to elaborate on problematic materials if needed or discuss questions which the groups disagreed on or answered incorrectly in their online discussion sessions.[14]

Glenda Morgan, of the University of Southern California, notes in her commentary on the five redesign strategies that "online quizzes and drill and practice feature strongly" in the supplemental category and "in many cases the online materials and activities allow for class time to be reassigned to include activities more supportive of student learning,"[15] such as discussion of difficult materials. The technologies used by the supplemental method vary considerably and can include online discussion forums, commercially-available course or textbook-specific programs, and teacher, course, or student websites and blogs. As a rule, successful course models use pre-

[10] Ibid. P 1.
[11] Ibid. P 2.
[12] Ibid. P 2.
[13] Ibid. P 2.
[14] Ibid. P 2.
[15] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 3. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)

packaged software often and move as many rote and practice activities as possible online to free up discussion time for more complex materials.[16]

Morgan echoes many other instructional technologies analysts in saying that "successful programs offered redesigned courses rather than just inserting technology into the curriculum."[17] Since the supplemental model most closely resembles the traditional means of delivering course content, it can be tempting for professors to simply superimpose technology onto the curriculum without actually considering how to use it effectively or what their goals in using it should be. In a 2005 interview, Carol Twigg also warns against this practice:

> We need leadership to come from the academic side—leadership that says, "These are our academic goals for the use of technology" rather than "Let's find ways that we can get the faculty to use technology." To the degree to which academic leaders are clear about what they're trying to achieve, technology can be a tremendous enabler to help them do so. But if you're just kind of fuzzy about what you're trying to achieve with students, you're not going to get very far.[18]

In addition to being clear on their goals for using instructional technology in a given course, professors need to actively and consistently engage their online or technology-centered class communities in order for students to get the most out of the experience. In other words, blogs, discussion forums, and other supplemental activities should at the very least be graded regularly, but ideally the professor joins the students' discussions regularly to keep participants involved and interested and to prevent the dialogue from becoming irrelevant to the course. William Pelz comments on the need for instructors to participate both as a grader and a moderator in many technology forums. As Pelz notes, "the common thread in…these learning activities is that the students do most of the work," he writes. However, the instructor must still provide "the necessary structure and directions, supportive and corrective feedback, and evaluation of the final product."[19] This interaction by the instructor takes a different form in a mathematics course than it does in an English or sociology class, but the general principle of remaining available to students and actively guiding their progress stands no matter what the subject.

The Hybrid Model

The major difference between the supplemental model and the hybrid model is that the former maintains the traditional number of face-to-face class meetings, but the

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[16] Ibid. P 6.
[17] Ibid. P 6.
[18] Veronikas, Susan Walsh and Michael F. Shaughnessy. "Teaching and Learning in a Hybrid World: An Interview with Carol Twigg." Educause. July/August 2004. P 3. (http://www.thencat.org/Articles/erm0443.pdf)
[19] Pelz, William. "(My) Three Principles of Effective Online Pedagogy." Journal of Asynchronous Learning Networks. The Sloan Consortium. June 2004. (http://www.sloan-c.org/publications/jaln/v8n3/v8n3_pelz.asp)

latter replaces some of those meetings with technology-centered activities. In this way, the hybrid model "replaces, rather than supplements, some in-class time with online, interactive learning activities" and "gives careful consideration to why (and how often) classes need to meet face-to-face."[20] It "assumes that certain activities can be better accomplished online—individually or in small groups—than in a face-to-face class."[21] By the same token, the hybrid model seeks to maximize the effectiveness of the face-to-face class time it preserves. Morgan offers a general guideline in which "between a quarter and two thirds of lectures and section meetings are replaced by online materials and activities." This, in turn, allows the remaining class time to be "redesigned so as to enable a higher quality of interaction between instructors and students."[22]

NCAT offers two examples of hybrid courses in which the number of class meetings is reduced but the content of the remaining ones remains the same. The Pennsylvania State University reduced the meetings of its Elementary Statistics classes from three to one weekly lecture and replaced the two face-to-face class meetings with on-campus computer studio labs in which students practice their materials independently and in groups. In order to ensure their participation, 30% of each student's grade comes from his or her performance on computer-based assessments delivered five to seven times per semester.[23] The technology-centered portions of mathematics classes are more likely than those of other subjects to take place in on-campus computer labs in both the hybrid and emporium models. These on-campus mathematics facilities often employ one or more student or faculty attendants to answer questions and help students who get stuck on the material.[24]

The General Chemistry curriculum at the University of Wisconsin-Madison was updated in the early 2000s to integrate online learning technologies. Lecture-based classes and discussion sessions have been reduced from two to one per week. Both the lecture and discussion classes have been replaced by interactive web-based tutorials, but the remaining class time is largely unchanged.[25]

Some hybrid models modify the face-to-face component of their courses when they introduced technology. Several schools in the Pew-funded research project chose to modify their entry-level foreign language courses by moving "grammar instruction,

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[20] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 2. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)
[21] Ibid. P 2.
[22] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 3. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)
[23] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 2-3. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)
[24] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 5. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)
[25] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 4. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)

practice exercises, testing, writing, and small-group activities focused on oral communication to the online environment."[26] Doing so enabled them to reduce class meetings from three to two per week and devote face-to-face instruction time to developing speaking skills which are difficult to cultivate online.[27]

The hybrid model was the most popular option among the Pew study participants in the early 2000s and remains the strongest method for many schools and a diverse array of courses today. Morgan summarizes its success relative to the other strategies in her 2006 best practices analysis:

> Projects choosing the replacement or hybrid model were more likely to report improved learning outcomes and completion rates than projects choosing other models. They also reported higher promise of sustainability and scalability. At some institutions (for example, the University of Central Florida) this model has been widely adopted beyond the scope of the original project and participation in the NCAT project.[28]

The hybrid format has been used for courses from many disciplines and continues to be regarded as the best option for course redesign among most higher education institutions.

The Emporium Model

The Emporium model "eliminates all class meetings and replaces them with a learning resource center featuring online materials and on-demand personalized assistance." The emporium model adds convenience for students since the computer-based work is self-paced and instruction "depends heavily on instructional software, including interactive tutorials, practice exercises, solutions to frequently asked questions, and online quizzes and tests."[29] Students can complete their work in the resource center any time it is open, though many schools using the emporium model retain mandatory course meetings at the resource center to ensure that students complete their assignments.[30] Morgan writes that "most emporium models retain some compulsory meeting time and format, such as a small group or section [meeting] for students to discuss [their] problems and experiences with the course."[31]

NCAT warns that the emporium strategy can require a significant investment of space for the center and money to purchase computers and software. Additionally,

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[26] Ibid. P 3.
[27] Ibid. P 3.
[28] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 5. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)
[29] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 3. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)
[30] Ibid. P 3.
[31] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 4. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)

students using the resource center still require faculty and staff assistance when they encounter difficult concepts and glitches in the technology itself. To fulfill this need, most centers are staffed by faculty, graduate teaching assistants, or proficient undergraduates, which means that personnel will remain a major expense with this model. By contrast, most course emporiums can be used for more than one section and even multiple courses. This versatility increases the school's overall return on investment.[32]

Virginia Tech's Math Emporium is widely considered to be one of the largest and most well-regarded emporium programs in existence. Founded in 1997, the Math Emporium "is a large learning environment housing 537 computers, lounge areas, breakout rooms, and presentation space in one 56,000 square foot room." The center is opened to students 24 hours a day, 7 days a week, but not always staffed.[33] Emporium courses at Virginia Tech are entirely asynchronous after an initial orientation meeting at the beginning of the semester, however, students are required to keep up with the work by the fact that each class has "weekly quizzes, four to five tests, and a final exam" which are synchronous.[34]

The instructional curriculum at the Math Emporium includes "reading the online lesson pages, watching supplementary video lectures, taking practice quizzes, and interacting face-to-face with math instructional assistants."[35] Emporium staff members are available on-site up to 12 hours a day to help students with their materials on an as-needed basis. The 40-50 staffers needed each semester can include Virginia Tech mathematics professors, graduate teaching assistants, and advanced undergraduate students.[36] As of fall 2006, Virginia Tech offered five math courses (some with multiple sections) exclusively through the Math Emporium. The total number of learners it served for that period was roughly 4,500 students.[37]

NCAT recommends Virginia Tech's asynchronous meeting plan only for classes where the students "are highly motivated, respond well to greater flexibility and are accustomed to scheduling work in the emporium around their other course responsibilities."[38] In other cases, colleges and universities have opted to use the emporium course format but keep mandatory class meetings. Both the University of

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[32] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 3. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)
[33] Ibid. P 93.
[34] Hodges, Charles B. and Jennifer M. Brill. "Developing a Training Program for Instructional Assistants within a Large-Scale Emporium-based Environment: A Nine Year Evolution Towards Systemic Change." International Journal of Teaching and Learning in Higher Education. 19.1. 2007. P 93. (http://www.isetl.org/ijtlhe/pdf/IJTLHE161.pdf)
[35] Ibid. P 93.
[36] Ibid. P 93.
[37] Ibid. P 93.
[38] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 4. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)

Alabama and the University of Idaho chose to implement a minimum time requirement for their students.

In particular, the University of Alabama offers a developmental course called Intermediate Algebra to roughly 1,500 students each year. At the beginning of the Pew program in 1999, the course had only a 40% first time pass rate and many students had to take it two or three times before they earned a passing grade.[39] Because the course had a history of impeding the progress of incoming freshmen, the university adopted a mandatory attendance policy which required students to log at least 3.5 hours per week in the math emporium and attend a traditional 30 minute class each week as well.[40] In the spring of 2001, the university experimented with the idea of dropping the 3.5 hour/week requirement, but found that student performance suffered markedly enough to justify the requirement.[41]

The emporium model met its greatest success in math instruction and the pioneering Virginia Tech program has been widely copied in the past ten years. While it is not regarded as highly overall as the hybrid model, there is no indication that schools are abandoning their emporium models. In fact, Virginia Tech continues to be "widely copied," but "within the NCAT project (and beyond) [the emporium model] has largely been limited to the discipline of mathematics and there are some reports of it having some limits even in this sphere."[42]

The Fully Online Model

The fully online strategy can have a number of different approaches which may or may not resemble traditional distance education courses. The model eliminates all face-to-face class meetings and moves all of content online. It typically:

> …adopts successful design elements of the supplemental, [hybrid], and emporium models including Web-based, multi-media resources, commercial software, automatically evaluated assessments with guided feedback, links to additional resources and alternative staffing models.[43]

This model is generally intended for large-scale courses which would otherwise require extensive involvement from instructors. It minimizes the need for professors to design and customize course content, personally conduct all course business and field inquiries from students, and spend a significant amount of time tending to the

[39] "Program in Course Redesign: The University of Alabama." NCAT. July 1, 2000. (http://www.thencat.org/PCR/R2/UA/UA_Overview.htm)
[40] "Lessons Learned: The University of Alabama." NCAT. December 31, 2002. (http://www.thencat.org/PCR/R2/UA/UA_FR3.htm)
[41] Ibid.
[42] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 5. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)
[43] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 4. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)

online class.[44] The fully online course model serves, above all else, to minimize the time an instructor spends on a given course while preserving and standardizing the course's instructional content.

NCAT divides fully online courses into two subgroups. The first of these depends very heavily upon commercially-available instructional software which presents the course content, quizzes the students, and offers instantaneous grading. Since course content is delivered via software, the course is entirely asynchronous with the exception of quizzes and exams, which usually remain standardized. In many cases, these courses have huge enrollments and some institutions have found it beneficial to hire a "course assistant to address non-content-related questions and to monitor students' progress, thus freeing the instructor to concentrate on academic rather than logistical interactions with students."[45]

NCAT profiles the fully online course program at Rio Salado College, which is one of ten community colleges in Arizona's Maricopa Community College District. The school "redesigned four math courses" so that they are now taught concurrently and entirely online under "one faculty member [who teaches a section of each course] to increase the number of students that can be served in a distance learning format and improve student retention."

The four courses included in the program are: Introductory Algebra, Mathematical Concepts/Applications, Intermediate Algebra, and College Algebra/Functions.[46] For several years prior to offering these courses entirely online, the college had been using "interactive software from Academic Systems to deliver content" and assist with student learning. The program proved popular with students and allowed faculty to assume much greater teaching loads. It eventually prompted the college to place the four courses entirely online where students could continue to use the Academic Systems software. The college also hired a course assistant to provide course management, communications, and student support on technical and logistical matters, which freed up the professors teaching each online section to concentrate exclusively on their students' academic progress.[47]

Rio Salado's experiment with software-based, fully online mathematics courses can be considered largely successful. Their major goal at the outset was to increase the "combined class capacity from 35 to 100 students per instructor"[48] without sacrificing instructional quality and student retention. Ultimately, the project had "no substantial impact on learning – positive or negative," and

[44] Ibid. P 4.
[45] Ibid. P 5.
[46] "Program in Course Redesign: Rio Salado College." NCAT. 2005. (http://www.thencat.org/PCR/R1/RSC/RSC_Overview.htm)
[47] Ibid.
[48] Ibid.

> …since the focus of the re-design project is structural (to increase substantially the numbers of students in an online course) rather than instructional, the fact that there was no impact is a good sign—i.e., student outcomes were not affected adversely.[49]

Unlike Rio Salado, some colleges and universities opted to use the fully online course strategy and develop the content themselves rather than relying upon commercial software. NCAT refers to this sub-type as the web-based online course model and, like the software based instructional programs, its main advantages are that it reduces the amount of time instructors must spend on courses and increases the number of students who can enroll.

The University of Southern Mississippi and Florida Gulf Coast University redesigned their World Literature and Fine Arts core courses around the online model as part of the Pew study. In both cases the schools' professors divided the course into modules based upon their areas of expertise and each module owner developed the content, quizzes, and tests for his or her portion of the course. The use of course coordinators to handle technical and logistical questions is a common practice in the web-based model. While it requires more faculty involvement than the software-based option, it still "eliminates duplication of effort for faculty who divide tasks among themselves and target their efforts to particular aspects of course delivery."[50]

The Buffet Model

The buffet model is intended to "customize the learning environment for each student based on background, learning preference, and academic/professional goals."[51] Content delivery formats are customized for each student based upon an online assessment of his or her learning style. They can include:

> …lectures, individual discovery laboratories (in-class and Web-based), team/group discovery laboratories, individual and group review (both live and remote), small-group study sessions, videos, remedial/prerequisite/procedure training modules, contacts for study groups, oral and written presentations, active large-group problem-solving, homework assignments (GTA graded or self-graded), and individual and group projects.[52]

By providing a variety of learning methods, the buffet model seeks to cater to the needs and preferences of each student to optimize the class's learning outcomes. Providing all of these options can be time-consuming and expensive, but in most cases instructors assume responsibility for different modules of the course content

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[49] "Improving the Quality of Student Learning: Rio Salado College." NCAT. 2005. (http://www.thencat.org/PCR/R1/RSC/RSC_PR1.htm)
[50] "Five Models for Course Redesign." The National Center for Academic Transformation. 2005. P 5. (http://www.center.rpi.edu/R2R/R2R%20PDFs/Five%20Models%20for%20Course%20Redesign.pdf)
[51] Ibid. P 5.
[52] Ibid. P 5.

and instructional formats in order to reduce the amount of time each one has to devote to the course. In the event that a particular format is underused or consistently delivers substandard outcomes, the school can eliminate that option from the buffet.[53]

Ohio State University was the only institution among the initial 30 grant participants to choose the buffet model, which it applied to its redesigned Introductory Statistical Concepts course.[54] The course traditionally enrolled over 3,000 students at OSU's main and branch campuses and had a failure rate of 20%. University planners decided to modularize the course into five sections, each worth one credit, and offer partial credit to students for each module they completed so that students who fell behind late in the semester would not have to retake the course from the beginning in the next quarter.[55] By enacting this partial credit scheme, the university hoped to "eliminate one-fourth of the course repetitions, thereby opening slots for an additional 150 students per year."[56]

Course format options available to Ohio State students include "online labs, live and online review sessions, small groups study sessions, large group problem solving, group projects and computer or TA-graded assessments, among others."[57] Students are assessed in the class's initial orientation meeting to determine their optimal learning style. The program's designers discovered early on that "students who missed the orientation and were unable to choose a section matching their learning style did worse" than those who were able to select their course sections.[58] The latter group showed significant improvements in retention and performance over students in the traditional model.[59]

Five Strategies of Course Redesign

Based upon its findings in the initial 30 Pew funded redesign projects and subsequent initiatives, NCAT compiled a short list of the top five best practices for integrating technology into the curriculum. All of the major ideas covered below are also apparent in the redesign examples cited throughout this section. The comments immediately following the bullet points are quoted verbatim.

- **Redesign the Whole Course:** In each model the whole course—rather than a single class or section—is the target of redesign. The course is

[53] Ibid. P 5.
[54] Ibid. P 5.
[55] "Program in Course Redesign: The Ohio State University." NCAT. 2005. (http://www.thencat.org/PCR/R3/OSU/OSU_Abstract.htm)
[56] Ibid.
[57] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. P 4. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf)
[58] "Program in Course Redesign: The Ohio State University." NCAT. 2005. (http://www.thencat.org/PCR/R3/OSU/OSU_Abstract.htm)
[59] Ibid.

treated as a set of products and services that can be continuously worked on and improved by all faculty rather than as a "one-off" that gets re-invented by individual faculty members each term.[60]

This major principle appears in nearly every reputable article on the topic of academic transformation and consistently reiterates the need to take heed of simply adding technology to a traditional course. While course redesign can ultimately improve student outcomes, save money, and increase the number of students individual faculty members can teach during a semester, it must be emphasized that the actual process of creating a successful technology-centered course requires a major investment of institutional resources.

❖ **Encourage Active Learning:** Each redesign model makes significant shifts in the teaching-learning enterprise, making it more active and learner-centered. Lectures and other face-to-face classroom presentations are replaced with an array of interactive materials and activities that move students from a passive, note-taking role to an active-learning orientation.[61]

William Pelz writes that his first principle in course redesign is to let the students do the work: "…regardless of what else is going on, the more 'quality' time students spend engaged in content, the more of that content they learn."[62]

❖ **Provide Students with Individualized Assistance:** Each model either replaces or supplements 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—and/or online, enabling students to have more one-on-one assistance. Students cannot live by software alone, however. When students get stuck, the tutorials built into most software programs are not enough to get them moving again. Students need human contact as well as encouragement and praise to assure them that they are on the right learning path.[63]

❖ **Build in Ongoing Assessment and (Prompt) Automated Feedback:** Increasing the amount and frequency of feedback to students is a well-documented pedagogical technique that leads to increased learning. Rather than relying on individual faculty members in small sections to provide

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[60] "Five Principles of Successful Course Redesign." The National Center for Academic Transformation. 2005. P 1. (http://www.center.rpi.edu/R2R/R2R%20PDFs/SuccCrsRed.pdf)
[61] Ibid. P 2.
[62] Pelz, William. "(My) Three Principles of Effective Online Pedagogy." Journal of Asynchronous Learning Networks. The Sloan Consortium. June 2004. (http://www.sloan-c.org/publications/jaln/v8n3/v8n3_pelz.asp)
[63] "Five Principles of Successful Course Redesign." The National Center for Academic Transformation. 2005. P 4. (http://www.center.rpi.edu/R2R/R2R%20PDFs/SuccCrsRed.pdf)

feedback for students—a technique known to increase faculty workload significantly—each model utilizes computer-based assessment strategies.[64]

❖ **Ensure Sufficient Time on Task and Monitor Student Progress:** Rather than depending on class meetings, the redesigns ensure student pacing and progress by requiring students to master specific learning objectives, frequently in modular format, according to scheduled milestones for completion. Although some projects initially thought of their designs as self-paced, open-entry/open-exit, they quickly discovered that students need structure (especially first-year students and especially in disciplines that may be required rather than chosen) and that most students simply will not make it in a totally self-paced environment.[65]

[64] Ibid. P 5.
[65] Ibid. P 8.

Additional Case Studies: Redesigning Foundation Courses

Even though the best practices presented in the previous section apply at all academic levels, colleges and universities that have redesigned their remedial and lower-level courses have found that certain practices must be emphasized while others do not apply to the same degree in this setting as they do in more advanced courses. In the following section, we offer two in-depth case studies of the academic transformation of lower-level courses at various institutions that participated in NCAT's *Program in Course Redesign (PCR)*. We conclude with some general lessons drawn from these institutions' experiences with foundational course transformation.

Elementary Algebra Course Redesign at Riverside Community College

The purpose of academic transformation at Riverside Community College leaned toward improving learning outcomes directly. At the outset of the project, Riverside faced historically low pass rates for its Elementary Algebra course. Roughly 50% of the students enrolling in the course failed to earn the grade of 'C' or better required for degree credit and around 30% of students repeated the course at least once. These statistics, coupled with a "very low retention rate, with many students simply giving up and dropping out," led the college to embark on a course redesign project in the early 2000's.[66]

Riverside replaced its original curriculum, which was based around four hours of lecture per week, with "participation in a Math Collaboratory and two hours of weekly Spotlight Sessions."[67] The Math Collaboratory resembled Virginia Tech's emporium strategy. It created opportunities for students to "work with faculty, tutors, and other students" and utilize the web-based ALEKS program in a lab setting. ALEKS is "an artificial intelligence math program that generates individualized assessments, study plans, and active learning sets" for students upon demand. It was ultimately deemed unsatisfactory due to "a number of problems" including "a lack of correlation between ALEKS and textbooks, tutorials that were very text-based and difficult to follow," and a design which prevented students from reviewing materials they had already covered.[68] Following the first semester of the pilot project, Riverside implemented the more popular software based *MyMathLab* to replace ALEKS.[69]

Initially, student attendance at the Math Collaboratory and the Spotlight Sessions was voluntary, but instructors quickly found that they were not devoting the necessary time to the class on their own. As a result, the college began to require all students to spend two hours in the Math Collaboratory and also attend two one-hour Spotlight

[66] "Program in Course Redesign: Riverside Community College." NCAT. 2005. (http://center.rpi.edu/PCR/R2/RCC/RCC_Abstract.htm)
[67] Ibid.
[68] Ibid.
[69] "Lessons Learned: Riverside Community College." NCAT. 2005. (http://center.rpi.edu/PCR/R2/RCC/RCC_FR3.htm)

Sessions each week regardless of their performance. During the fall 2001 and spring 2002 trial semesters, it was found that students in the redesigned courses scored "significantly higher" than their peers in traditional courses on four and two of the course's 6 major objectives respectively.[70]

The study found no other statistically significant differences in learning objectives satisfied, retention rates, and success in subsequent math courses between the traditional and redesigned model.[71] As of fall 2002, "RCC began offering a choice of either the redesigned or traditional lecture format at two of the campuses" in response to faculty members who preferred the traditional course model to the redesign. In total, the college offered "11 redesigned sections (enrolling 805 students) and 10 traditional sections (enrolling 500 students)."[72]

The overall improvement in student performance fostered by the redesign project was fairly small but still noticeable. By the end of the trial period even the reinstated traditional classes continued to use the Math Collaboratory and *MyMathLab* to augment text and lecture-based learning.[73] Because of this combination of old and redesigned teaching methods, the school can now be said to offer both a supplemental and hybrid course model for Elementary Algebra.

College Composition Course Redesign at Tallahassee Community College

Tallahassee Community College redesigned its basic composition course in the early 2000s using the hybrid model. The course had an enrollment of 3,000 students each year, who were traditionally taught in class sections of 30 students in "a format that combines lecture, discussion, and writing activities."[74] Success rates for the College Composition historically hovered below 60% and students often had to retake it. The need to re-teach basic skills to some students and the extensive use of adjunct faculty members to meet demand for instructors meant that the curriculum was not nearly as standardized as the college would have liked.[75]

The school's basic redesign plan incorporated many of the strategies seen above. They sought to shift "many basic instructional activities that can be readily individualized to the online environment" and free up class time for guided writing exercises, collaborative work, and other higher level, interactive activities. The school began offering interactive online tutorials in grammar, mechanics, reading comprehension, and basic research skills and implemented the use of online

[70] "Impact on Students: Riverside Community College." NCAT. 2005. (http://center.rpi.edu/PCR/R2/RCC/RCC_FR1.htm)
[71] Ibid.
[72] "Sustainability: Riverside Community College." NCAT. 2005. (http://center.rpi.edu/PCR/R2/RCC/RCC_FR4.htm)
[73] Ibid.
[74] "Program in Course Redesign: Tallahassee Community College." NCAT. 2005. (http://www.thencat.org/PCR/R3/TCC/TCC_Abstract.htm)
[75] Ibid.

discussion boards to facilitate learning communities among students.[76] In order to reduce the time instructors spent grading assignments, students were required to "submit mid-stage drafts to online tutors at the college's writing center or to SMARTHINKING," which is a D.C.-based firm offering online tutoring to students.[77] NCAT places the Tallahassee Community College strategy under the hybrid category of course redesign since it places many simpler instructional and grading functions online and devotes the remaining in-class time to active learning activities.

Results from the pilot redesign program showed a moderate improvement in student success rates, which were 78.4% among students in the redesigned course compared to 70.7% among traditional students.[78] The program was able to increase the percentage of adjunct faculty teaching English Composition and thereby use its full-time faculty members to teach higher level courses. Because a significant portion of course instructional content was moved online, the use of adjuncts did not seriously threaten course standardization.

In addition to using more adjuncts for its composition course, TCC also outsourced a significant amount of grading and on-demand writing instruction, thereby reducing the percentage of English Composition students who visit the writing center during the course from nearly 50% to 34%.[79] Despite the fact that the redesign program's main goal was to improve student performance, the initiative's most drastic gains were those involving the use of faculty time and school resources.

Basic Principles for Lower-Level Courses and Technology Integration

As a general rule, community colleges have experienced moderate improvements in both cost reduction and academic performance from engaging in academic transformation projects. Large-scale course redesign strategies have continued to attract interest among higher education institutions at all levels since the initial NCAT-Pew studies of the late 1990s and early 2000s. NCAT's continuous updates about new and ongoing projects reveal that the trend shows no sign of abating.[80]

Emerging best practices for developmental and lower-level courses suggest that the major benefit of introducing technology into the curriculum is the fact that it enables professors to teach more students effectively by outsourcing many grading and basic instructional functions, thereby freeing up more time for student interaction. This

[76] Ibid.
[77] Ibid.
[78] "Impact on Students: Tallahassee Community College." NCAT. 2005. (http://www.thencat.org/PCR/R3/TCC/TCC_FR1.htm)
[79] "Impact on Cost Savings: Tallahassee Community College." NCAT. 2005. (http://www.thencat.org/PCR/R3/TCC/TCC_FR2.htm)
[80] See NCAT's frequent discussions of new and ongoing projects: "The Learning Market Space." National Center for Academic Transformation. 2003-2007. (http://www.thencat.org/subscribe.htm#Issues)

benefit can be enhanced by the use of instructional software or private educational firms such as SMARTHINKING for low-level grading.

Course redesign's second major advantage is that it increases the amount of interactivity students have with the material and changes class time from a lecture format to one in which professors can concentrate on major issues arising from their students' involvement with the material and provide more individualized assistance. The increased use of interactive activities in class can transform the professor's role from that of a lecturer to that of a guide and allows instructors to respond to students' needs as they arise during their direct engagement with the subject matter.

Lower-level course designers have discovered that mandating student attendance at labs and workshops improves student performance significantly because many students, particularly freshmen, fail to spend a sufficient amount of time with the materials otherwise. Some instructional programs, such as the Academic Systems math software, have the capacity to automatically update instructors about students' progress or lack thereof.[81] This capability greatly enhances professors' ability to track the amount of time students spend on the course materials and the level of comprehension they obtain. The intelligent use of technology enables teachers to reach out to students who appear to be having trouble before they fall too far behind.

[81] "Program in Course Redesign: Rio Salado College." NCAT. 2005. (http://www.thencat.org/PCR/R1/RSC/RSC_Overview.htm)

The Impact of Integrating Technology in the Classroom

Over the course of this report, Hanover has offered a synopsis of best practices in integrating technology in the post-secondary classroom. To this effect, incorporating technology in higher education does not simply suggest introducing new, technology-based learning tools and teaching strategies, but implies a strategic reconsideration of the way in which courses are structured and delivered. As the examples and case studies of institutions participating in the NCAT study illustrate, technology-centered course redesign programs seek to maximize student engagement and reduce the costs of course delivery. In the remainder of this report, we recapitulate some of the major lessons and impacts of course redesign at higher education institutions as it relates to integrating new forms of technology. Among the stated advantages of technology integration are: a transition to practice-based classrooms, automated feedback and performance assessments, and a reduction in course delivery costs.

Practice-Based Classrooms

The NCAT strongly emphasizes a curriculum-design strategy in which in-class lecture time is minimized and students engage the material under the guidance of faculty members and tutors. This strategy shifts the main function of class time from lecture to practice, and as a consequence, students in redesigned courses must be introduced to the course content primarily outside of class. Successful course models use prepackaged software often and move as many rote and practice activities as possible online to free up discussion time for more complex materials.[82] Instructor-student interaction becomes a tool to strengthen students' understanding and address any difficulties they encounter in their out of class activities. In this manner, online discussion forums, commercially-available course or textbook-specific programs, and teacher, course, or student websites and blogs allow for students to gain a basic understanding of course concepts.

In order for technology-based redesign to be successful, the lessons delivered outside of class must effectively engage students. Additionally, their related homework assignments have to gauge whether or not they are learning the material and, ideally, provide an overview of each students' progress to the course instructor before the class meets in person. For a redesign to be effective, its out-of-class component must mimic a human instructor's ability to explain difficult concepts, provide interactive examples, and assess whether or not the student is learning the material and, if he is not, what concept(s) are causing him to fail.

[82] Morgan, Glenda. "Best Practices in Academic Transformation." CSU, Office of the Chancellor. September 2006. (http://www.calstate.edu/ats/transforming_course_design/documents/Academic-Transformation-best-practices.pdf) P 6.

Individualized Performance Assessments

Prior to the advent of advanced instructional technology, high-level interaction involving both teaching and assessment could only have been provided by a human tutor or instructor. Now, there are a variety of programs available, both through academic publishing companies and independent firms that can perform both of these functions. NCAT regularly discusses the importance of both tutoring and assessment as learning tools and the centrality of these capabilities in course redesign efforts:

> Rather than relying on individual faculty members in small sections to provide feedback to students…courses involved in the Program in Course Redesign incorporate automated grading that provides immediate feedback to students wherever possible.[83]
>
> Automated grading and feedback probes students' preparedness and conceptual understanding, motivates them to keep on top of course material and encourages them to spend more time on task. Students receive diagnostic feedback that points out why an incorrect response is inappropriate and directs them to material needing review.[84]

Cost Effectiveness

NCAT consistently cites the cost effectiveness of academic transformation. They contend that during the 1999-2004 Pew funded experiment with course redesign, "all thirty institutions were able to reduce instructional costs, on average by 37%, with a range of 20% to 77%."[85] In a briefing published under The National Center for Public Policy and Higher Education, Carol Twigg, argues that the greatest financial benefits of academic transformation can be reaped by targeting "large-enrollment, introductory courses that reach significant student numbers."[86]

Twigg's key methods of cost control are all among the techniques mentioned throughout the case studies offered above. They include course management systems which allow faculty to track student progress, shared course resources to increase standardization and reduce the work that individual faculty members put into customizing their course sections, the use of software for automated instruction and grading, and the use of course assistants to reduce the time professors spend on housekeeping matters.[87]

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[83] Twigg, Carol A. "Can Online Education Scale?" The National Center for Academic Transformation. 2005. (http://www.center.rpi.edu/PlanRes/Online%20Ed%20Editorial.htm)
[84] Ibid.
[85] "NCAT's Frequently Asked Questions." National Center for Academic Transformation. 2005. (http://center.rpi.edu/FAQ.htm)
[86] Twigg, Carol. "Course Redesign Improves Learning and Reduces Cost." The National Center for Public Policy and Higher Education. June 2005. P 2. (http://www.highereducation.org/reports/pa_core/core.pdf)
[87] Ibid. P 5.

Note

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