Early Followers Reap Benefits and Lower Costs

Using existing online materials in restructured courses gives students multiple ways to learn — and keeps costs down

By **Deborah Walters, Carl Alphonce, Helene Kershner,** and **Debra Burhans**

Early adopters of educational technology have found that most uses of technology to improve learning increase costs both in terms of faculty time and in technology costs. For example, the development of the case-based ethics software at Carnegie Mellon University[1] required a significant investment of faculty time to create a rich online environment. While many early adopters have willingly spent the many additional hours required to develop and mount technology-enhanced or online courses, this model doesn't scale for two reasons:

- While an early adopter might be willing to devote large amounts of time to a course initially, if the course continues to require significant additional effort, faculty members often find themselves unable or unwilling to maintain the commitment.
- When other faculty members observe the amount of time invested by early adopters, other faculty sometimes become even less willing to engage in such activity themselves.

This issue of additional effort becomes especially troublesome when faculty members face increasing demands on their time from other directions.

Many early adopters have also found an increase in costs associated with the technology itself: hardware costs, maintenance costs, software costs, connectivity costs, and more. For example,

- The studio classrooms at Rensselaer Polytechnic Institute[2] and the Math Emporium at Virginia Tech[3] required significant capital costs to build and equip.
- Synchronous videoconferencing-style courses can be expensive in terms of building facilities and recurring line charges.
- In addition, where students didn't already have access to computers, the early adopters had to deal with the costs of providing such access.

These cost increases can be problematic, especially if the containment of rising costs is a priority at a college or university.

Technology as a Change Lever

Despite the time and resource costs encountered by early adopters, the increasing use of technology in higher education can provide a lever for change. The case study described here demonstrates how new uses of technology in teaching and learning let us reconsider how to deliver education and develop a culture of deliberate change.

At our university, tradition in higher education mandates having the faculty design and deliver the curriculum, while the administrators consider costs and resource management. This results in a disconnect between curriculum design and cost, which may lead to less than optimal decisions. We found that technology can help bridge this gap. When faculty members think about both the role of technology in education and the constraints of cost, the deep faculty pool of creativity and intelligence can yield new approaches to learning that are both pedagogically sound and have the potential to scale beyond the early adopters.

Technology has provided a lever for change not only in the consideration of costs, but also in the consideration of pedagogy. Nora Sabelli, Senior Project Director of the National Science Foundation's Education and Human Resources program, called for a move from passive to active learning. She described the interaction between passive versus active learning and technology using the diagram in Figure 1,[4] with the goal being movement from

Figure 1

Interactions Between Pedagogy and Technology

	Low Technology	High Technology
Passive Pedagogy	Lectures	Distance Learning
Active Pedagogy	Project-based	Project-based Simulations, etc.

the upper left quadrant to the lower two quadrants.

Some of our faculty members expressed interest in incorporating technology into their courses, but not in contemplating the effects of different pedagogies. For those faculty members technology became a change lever — thinking about and researching new uses of technology motivated discussions and considerations of pedagogy.

Pew Learning and Technology Program

Through a grant from the Pew Learning and Technology Program[5,6] (PLTP), we formed a faculty team at University of Buffalo (UB) to restructure a large-enrollment computer fluency course. The PLTP's goal is to demonstrate how using technology can increase student learning while reducing costs.

The program provides grantees with a structured method for analyzing the full costs of a course. By applying the method to both a traditionally taught course and a restructured version of the course, it's possible to determine the added costs or cost savings for a contemplated change in course structure.

One advantage of this methodology is that it enables faculty to quantitatively measure the cost consequences of a course restructuring. The main advantage comes from simply engaging faculty in the consideration of costs — the various tradeoffs between ideal, but unaffordable, instructional methods and more cost effective, yet pedagogically sound, instruction. Through such discussions, creative solutions to the tradeoffs can arise that may be superior to even the high-cost methods previously employed.

Redesign of a Computer Fluency Course

The faculty team redesigned a computer fluency course for non-majors. The traditional course involved, per week, three hours of 200-seat lectures taught by faculty and two hours of 30-seat labs taught by graduate teaching assistants.

The first step was to determine the learning goals for the course. The team had followed the work of the National Research Council committee charged to answer the question, "What should everyone know about computers and information technology?" Their report, "Be FIT: Fluency in Information Technology,"[7] identified three classes of learning goals: concepts, skills, and capabilities (or critical thinking). The report argued that computer literacy courses that only teach skills could be improved by including concepts and critical thinking as well. For each of the three areas, the report specified 10 specific learning goals. Since the UB course already included all three areas, the team chose to adopt almost all of the 30 learning goals specified in the "Be FIT" report.

The next step was to determine those aspects of a computer fluency course amenable to improvement through increased use of technology and those aspects best left in their more traditional form. This process led to the following general goals for the redesigned course:

- To increase learning, especially active learning
- To provide multiple means for students to learn the course concepts and skills
- To preserve or even increase the face-to-face contact
- To decrease costs

Despite what appeared initially to be conflicting goals, we on the team used this list to constrain our thinking about the redesigned structure of the course. Adding considerations of how to use technology to achieve the goals, we found we needed new ideas for the course structure. These realizations caused us to rethink the basic pedagogy of the course, looking for novel solutions to satisfy the constraints.

The team predicted increases in learning from an increase in lab hours, made possible through the use of undergraduate learning assistants, online grading, and fewer lecture hours. The Web-based and CD-ROM supplemental materials provide students with multiple means of learning the conceptual material otherwise covered in lectures. In addition, evidence exists that for some topics students learn more from the experiential, active learning that takes place during labs than from lectures.[8] For example, watching a professor demonstrate how to use a spreadsheet during a lecture is less effective than participating in an active learning exercise in a lab.

Short video clips of parts of the lectures that present hard-to-grasp concepts will let students watch and listen to the presentation multiple times when these items are placed on the course Web site. In addition, the team is creating short video clips on topics like setting up an e-mail account at the university and other site-specific items.

The team also expects use of online diagnostic quizzes to result in increased student learning. Online tests in which the computer grades all but the essay questions may also lead to better learning, as the students receive immediate feedback on their performance. This online testing, grading, and automatic grade reporting will also save faculty time. In addition, using the automatic randomization and selection of test questions reduces the faculty time spent in test preparation.

Since this particular course targets students who aren't comfortable with computer technology, the team found it inadvisable to replace the bulk of the course with purely online instruction. In fact, the team felt that more one-on-one, face-to-face learning opportunities were needed to give the students computer fluency. The challenge was providing this while reducing costs.

One part of the solution involves online testing and a commercial course management system, which permits using undergraduate student learning assistants (ULAs) in place of graduate student teaching assistants (GTAs). Without this use of technology, it's not possible to use ULAs, as our university forbids ULAs from grading and grade recording.

Using ULAs for this course has several pedagogical advantages. First, the GTAs

were typically computer science and engineering graduate students new to the United States and unfamiliar with U.S. undergraduate education and culture. Often a mismatch occurred between the undergraduates, many of them computer-phobic, and the graduate students, who had been computer savvy for years. ULAs, on the other hand, tend to be undergraduates from disciplines other than computer science and engineering. Having more recently learned the basic concepts of computing themselves, they can better comprehend the misunderstandings common among novice users. In addition, since GTAs cost more than twice as much as ULAs, it's possible to double the number of assistants and still reduce costs. This means that more students can receive face-to-face help at once.

To help reduce development and maintenance costs, the faculty team decided to use existing online active learning materials available from either textbook publishers or faculty at other institutions. In addition, we recommended a commercially available course-management system rather than having faculty members write their own software. Thus, by being early followers rather than early adopters, we expect to see time (and thus cost) savings not possible for early adopters, who must create much of their own courseware.

During the first year of the restructuring project the faculty team reviewed and selected commercially available online and CD-ROM materials, and collected baseline data from the course (still being taught in its traditional form). The full-scale implementation, which began in the second year of the project, was still in progress at the time we wrote this article.

The success of the restructured course will be judged by comparing changes in student learning, differences in student attitudes toward computer use, and total costs in the new course versus the baseline data collected from the traditional course. While most of the cost data is already available, the learning data won't be available until students complete the first year of the redesigned course.

Outcomes and Significance

The per-student cost of the course in the first year has dropped from $248 to $152 with the enrollment held constant. Thus significant cost savings are possible with the redesign. The institution sees these cost savings as actual cost savings — fewer dollars expended by hiring undergraduate rather than graduate assistants. In future years faculty members should see some savings in terms of their time commitment, as we predict less time needed for lecture preparation, lecture presentation, test preparation, test grading, and grade reporting in subsequent offerings of the course. In this case faculty members will spend less time on some management aspects of the course, letting them spend more time on student interactions or other activities such as computer science education research. While the faculty team believes that learning will also improve, the results of testing this hypothesis aren't yet available.

The importance of our results goes beyond the effect on a single course at a single institution. This work can serve as a model for other teams within the university.

As a second outcome the faculty team has become well versed in considering the costs of instruction when designing courses. One benefit shows up in the redesign of the specific course, but faculty members also can now apply what they've learned to redesigning other courses.

The importance of our results goes beyond the effect on a single course at a single institution. This work can serve as a model for other teams within the university, for example, as faculty members communicate their experiences to other faculty. It can also serve as a model for faculty at other institutions. Finally, restructuring courses with an increased use of new technologies, considering both pedagogy and the costs of instruction in the process, can create a positive culture of change that may spread throughout the university.

Early Followers versus Early Adopters

Based on our experience in our course redesign, we better understand the differences between the early adopters of technology and ourselves as early followers. Others can use as a general guide the following five main advantages we found as early followers:

- Early followers don't have to create the majority of the online course materials for a course.

Instead, they can use existing materials available either from the early adopter professors or from textbook publishers. Early followers argue that creating online course materials is akin to writing a textbook. Certainly not every professor writes his or her own textbook. When a professor adopts a textbook she didn't write, she picks and chooses from among its topics, provides additional course materials in areas she wishes to emphasize, and in general creates a course that bears her own imprint. Similarly, not every professor will write his own online course materials. When using materials from other sources, he will selectively customize them to reflect his own approach to the subject matter.

- By using commercially available course management software, early followers can avoid some of the costs encountered by early adopters in creating components of such software.

In some cases institutions incur additional costs through the licensing of course-management software and the maintenance and hardware costs of servers for its installation. A second option is to let the textbook publisher provide the course-management software from a centrally maintained site,

then pass the cost on to the students as part of their textbook purchase.

- By using existing online course materials and commercially available course-management systems, the early follower doesn't have to spend large amounts of time in creating materials that the early adopter does.

Potentially, this can lead to significant savings in faculty time. However, compared to not using technology at all, there's a significant faculty time investment in selecting and testing online materials. Good technical support is also required to install and test the materials in the local setting.

- Another difference is that the early follower often encounters students who already have access to computers and the Internet. At some universities students are expected to either purchase their own computer or to otherwise find access to a machine.[9,10] Many institutions also provide computer-equipped labs for student use on campus, as well as the connectivity required for Internet access. Thus the early follower often faces situations where incorporating technology-based changes into courses won't significantly increase hardware, software, maintenance, and connectivity costs. External forces have already prompted institutions of higher education to provide the computing infrastructure — early followers simply use that infrastructure in additional ways.
- A final benefit for the early follower over the early adopter is increased knowledge of potential pedagogical advantages and disadvantages from using various types of technology in higher education.

In other words, the early follower benefits from the early adopter having already started up the learning curve of technology's effects on teaching and learning. Following makes for fewer missteps and more targeted applications in this case — a benefit indeed. *e*

Endnotes

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